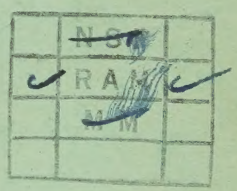
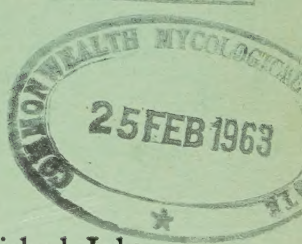
ANNUAL REPORT
1961/62

COFFEE RESEARCH STATION, RUIRU

AND

COFFEE RESEARCH SERVICES
KENYA





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INTRODUCTION

The year under review will be remembered for its contrast of drought and deluge. The first eight months were marked by poor rainfall and high temperatures after sub-normal rainfall during 1960 throughout all districts East of the Rift. Good rainfall in September was a presage of the deluge which followed in the Short Rains. The rainfall pattern was similar in the Rift Valley and West of the Rift—very heavy following eight months of poor rains.

For the third successive year the trees carried an abnormal weight of early crop which drought brought to ripeness prematurely. In consequence, much of the crop was of poor size and quality. The late crop, harvested in the last quarter, was of normal size and quality; but continuous wet weather throughout the peak of the harvest hindered natural drying and the complex processes needed for maintenance of quality.

Despite sub-normal rainfall since September 1958, the infection levels of Leaf Rust and Coffee Berry Disease were sufficiently maintained to cause concern and loss of crop in the regions where these diseases are normally endemic. Prolonged wet weather from mid-October onwards provided ideal conditions for a rapid increase of both diseases, to a degree not encountered for many years. Even at lower elevations Coffee Berry Disease caused loss of crop at economic levels. By the end of the year, Leaf Rust outbreaks were general and severe, particularly in the lower zones.

Inches per month	A	B	C	D	E	F	G	H
January	0.28	0.05	0.53	0.12	0.54	0.27	1.19	0.00
February	0.68	0.17	0.64	1.24	3.80	0.95	1.49	2.71
March	3.56	2.25	4.96	0.71	6.50	4.47	2.75	4.77
April	6.84	6.49	11.47	4.49	7.79	7.49	15.12	5.78
May	5.58	5.70	1.68	4.82	2.40	4.95	8.00	4.84
June	1.74	0.20	0.60	5.33	6.17	1.16	0.41	4.03
July	1.16	0.46	0.10	8.81	1.82	0.91	0.34	2.77
August	0.72	0.39	0.08	7.78	4.66	1.55	1.37	9.26
September	3.39	2.30	0.71	5.10	7.18	3.73	2.29	7.92
October	8.64	5.80	—	9.12	10.41	11.42	40.40	4.05
November	17.71	23.64	—	14.59	27.51	30.01	42.28	17.74
December	6.98	13.96	—	5.27	5.87	8.18	2.85	11.32
Total	57.28	61.41	20.77	67.38	84.65	75.09	118.49	75.19
No. of days Rainfall	153	125	47	182	227	163	128	192
Means and number of years	39.93 17	37.86 36	35.91 22	46.19 28	73.62 18	— —	— —	— —

A = Coffee Research Station, Ruiru
B = Scott Agricultural Laboratories, Kabete
C = North Kitito Estate, Makuyu
D = Kitale Experimental Station
E = Kisii Coffee Research Substation
F = Upper Kiambu Coffee Research Substation
G = Mariene Coffee Research Substation, Meru
H = Koru Research Substation

Mr. Wheatley took charge of Coffee Services when Mr. Jones proceeded on vacation leave in February. The following officers were appointed during the year:—

Messrs. J. Joshi, Z. Oyando, J. H. G. Waithaka and A. M. Pratt. Mrs. N. Forsythe was transferred from the Veterinary Department and Mr. I. R. Wallace transferred to the Field Division of the Agricultural Department. The following officers resigned on completing their contracts:—

Messrs. C. L. Gough, I. S. Leviseur, W. F. Coltman and M. H. Uiterdyk.

In contrast to the severe upsurge of disease towards the end of the year, the whole period was notable for relative freedom from insect pest damage, particularly Leaf Miner. In June Dr. Bess, Senior Professor of Entomology at the University of Hawaii, concluded his nine months' attachment on a Fulbright Scholarship. During this time he completed a study of the integration of biological and chemical control, related chiefly to the bionomics of Leaf Miner. Some clear-cut conclusions were reached and the results of this intensive study have undoubtedly made a valuable contribution to a clearer understanding of the circumstances which affect Leaf Miner outbreaks. Another outstanding advance made during the year has been the evolution of a satisfactory bioassay technique for evaluating insecticides. Further advances were made in improving knowledge and perfecting controls for both major and minor pests of coffee.

In the field of Plant Pathology very good progress was made in two lines of investigation which are of particular interest to growers. Means of applying fungicides with full efficiency and at low volume constitute an aim of great economic significance. In their co-operative project Messrs. Firman and Wallis showed that this aim can be achieved in the control of Leaf Rust. The study to determine the effect of fumigation of nursery beds with nematocide produced outstanding effects on the root system of coffee seedlings, although the cause and the practical implication of the results are not yet clear.

Three main projects constitute the major portion of the research programme in coffee physiology. It is now possible to trace the pattern of carbohydrate fluctuation in the tree throughout the crop cycle. Similar progress has been made in determining the influence of soil moisture availability on stomatal aperture. In the third project the cause of the "Crinkle Leaf" condition eludes discovery and study is now confined to the use of Captan as a control measure.

Field trials at the Makuyu substation reached a point in 1961 where conclusive evidence had been obtained. A review of the future functions of the station led to a decision for its closure in September. Among a wide range of long-term cultural problems the study of tillage practice reached a conclusive stage during the year. After 15 years the value of frequent weed control and the role of mulch and manure in combination with tillage are now well established.

A long-term project for the breeding of coffee with particular reference to Leaf Rust resistance, was planned as a co-operative undertaking with the Coffee Research Station, Lyamungu, Tanganyika.

Coffee Processing Research has continued on the lines pursued in 1960. Work on ventilated conditioning bins and their utilisation was brought to a successful conclusion. A first stage dryer was developed by Mr. Johnson, Agricultural Engineer at Nakuru, and was subjected to a series of evaluation tests to determine suitable methods of operation. Officers of the East African Industrial Research Organisation have continued their work on several aspects of processing. Mr. A. E. Wootton successfully concluded his study of "onion flavour". Dr. B. N. Ghosh undertook investigations of several aspects related to the mechanical handling of coffee.

The demand for coffee seed decreased from the very high level of the previous year, this decrease being due entirely to a contraction in the requirements of plantations in the scheduled areas. Seed issues totalled 6,991 lb. to plantations, 5,366 lb. to African Co-operative Societies and 119 lb. to other territories, making a total of 12,476 lb. of seed.

ADVISORY AND EXTENSION SERVICES

The advisory and extension service available to growers was maintained at the 1960/61 level, although there has been some decline in the number of requests for advice. In addition to the normal channels by which advice is provided to growers from the station and substations, the range of the advisory service is illustrated by the following:—

General Advisory Service. Mr. Cottington made 371 visits to plantations, with three tours of Rift Valley and three tours in Nyeri district during the year. Mr. Cottington also undertook advisory work in the Nyanza Scheduled areas until July when Mr. Scott was posted to the Koru substation Mr. Goodwin continued as advisory officer in Upper Kiambu, Limuru and Kabete districts until his transfer to Kitale at the end of September. Mr. Cottington was then made responsible for these districts until the arrival of Mr. de Vink at the Upper Kiambu substation in December. Mr. de Vink was responsible for advisory work in the Trans Nzoia, Uasin Gishu and Kaimosi districts from the beginning of the year until the end of September when these districts were taken over by Mr. Goodwin.

District Tours. In addition to routine tours by Messrs. Cottington and Hanger, a considerable number of district tours were undertaken by Messrs. Jones, Wheatley, Crowe, Wormer, Wallis, Firman, Harrison and Pratt.

Field Days. Displays by the Entomology, Plant Pathology and Plant Physiology sections were exhibited at the Annual Planters' Day held at Kilooma Estate. A Field Day was arranged for local planters at the Kitale substation in June. Mr. Cottington attended the Coffee Board of Kenya stand at the Nakuru Show in June and Mr. Goodwin attended their stand at the Eldoret Show in March.

Courses and Lectures. Three Coffee Courses were held at the Coffee Research Station for Senior Agricultural Department staff from the Nyanza, Rift Valley, Central, Southern and Coast Provinces. Lectures were given by the Extension and Research Officers of the Coffee Research Team.

Lectures were given by Mr. Hanger to various Coffee Societies and to farmers attending courses at Farmers' Training Centres.

A monthly broadcast to African coffee farmers was broadcast in Swahili on the K.B.S. African National Service. At the end of the year broadcasts in vernacular languages (Kikuyu, Kimeru and Kikamba) were initiated. All programmes are discussion programmes with a farmer and two or three other speakers.

A considerable amount of time was expended on the production of extension literature for distribution to African Coffee Districts.

Publications. The fifth separate edition of the Coffee Services Annual Report was published in July. The Atlas of Coffee Pests and Diseases was also published in July and at the end of the year a total of 711 copies had been sold. The "Better Coffee Farming" notes were continued as a monthly feature in *Kenya Coffee* as a means of passing information and advice to growers.

PUBLICATIONS

The following articles were published in *Kenya Coffee*, the Coffee Board of Kenya monthly bulletin:—

1961. VOL. XXVI

April "Ventilation Bins", by C. L. Gough.

May "The Place of Herbicides in the Management of Kenya Coffee (Part 2: Control of Perennial Grasses)", by J. A. N. Wallis.

September "The Propagation of *Coffea arabica* Using Intermittent Mist", by B. F. Hanger.

December "Fertilizers, Manure, and Mulch in Kenya Coffee Growing", by P. A. Jones, J. B. D. Robinson and J. A. N. Wallis.

1962. VOL. XXVII

January "The Star Scale", by T. J. Crowe.

March "The White Waxy Scale", by T. J. Crowe.

Articles published in other Journals during the year were as follows:—

Crowe, T. J.
(Glynne Jones, G. D.
and Williamson R.) "The Use of Pyrethrum Formulations to Control *Antestiopsis* in East Africa." *Bull. ent. Res.* **52,** 31–41.

Crowe, T. J. (1961) "The Use of Insecticides on Coffee in East Africa". *Agric. vet. Chem.* **2,** 77–80.

FIELD INVESTIGATIONS

EXPERIMENTAL SITES

The principal field investigations have been carried out at the Coffee Research Station near Ruiru where research into this crop has been centred since the Second World War. The application of experimental results are further tested at substations under a wide range of ecological conditions. These have been established at the sites shown below as centres of technical information as well as for research under local conditions. Some trials are situated on general agricultural experiment stations and in 1959 four trials were laid down on Saboti Estate near Kitale.

Experimental site	*Latitude*	*Longitude*	*Altitude ft.*	*Inches Rainfall/year*		*Acres Coffee*	*Period of Research*
				Mean	*Years*		
Coffee Research Station, Ruiru	1.06S	36.45E	5,300	39	15	104	1944–
Coffee Research Substations							
Kitale	1.00N	35.01E	6,200	45	24	15	1938–
Meru	0.00	37.35E	5,300	62	1	19	1958–
Koru	0.07S	35.16E	5,000	50	1	40	1959–
Kisii	0.41S	34.47E	5,600	73	17	21	1957–
Makuyu	0.55S	37.15E	4,800	37	19	2	1938–1961
Upper Kiambu	1.08S	36.46E	6,300	43	2	10	1957–
Saboti Estate, Mount Elgon, Kitale	0.57N	34.49E	6,600	49	34	8	1959–
Cotton Experiment Station, Busia	0.28N	34.07E	4,100	55	3	8	1958–
Agricultural Investigation Centre, Embu	0.31S	37.26E	4,800	45	17	4	1950–
Scott Agricultural Laboratories, Kabete	1.15S	36.46E	5,700	37	34	5	1920–

In 1950 a programme of variety trials was initiated and these have been planted on the stations shown above and also on numerous private coffee farms throughout the regions of Kenya known or thought to be suitable for coffee.

ANALYSIS OF EXPERIMENTAL RESULTS

In a properly designed experiment any observed effect may be tested to assess the probability of it occuring by chance. In this report three values are given for the "Least significant difference" for most trials.

$p = 0.05 = 5.0\% = * = 19:1$
$p = 0.01 = 1.0\% = ** = 99:1$
$p = 0.001 = 0.1\% = *** = 999:1$

For example, even if no treatment had been applied a difference as great as the value shown for $p=0.05$ would be expected once in twenty times, while a difference as great as the value given for $p=0.001$ would occur by chance once in a thousand times and therefore an observed difference of this magnitude can be accepted as real with great confidence.

CULTIVATION TRIALS

Coffee Research Station: Cultivation Trial

This trial commenced in 1947 when it was laid down on old coffee spaced at 10 ft. × 10 ft. The original complex experiment was progressively simplified and reduced in extent and now consists

of three replications of a 3^2 factorial layout with 40-tree main plots split once for testing cattle-manure. The treatments and 1961 yields are given in Table I.

TABLE I

1961 *YIELDS*

(cwt. clean coffee per acre)

Tillage Implement and Weeding Treatments	*Athi Plains Manure*		*Response*	*Means for main treatments*
	Nil	*1 × 4 gall. tin per tree*		
Forked hand hoe	5.11	6.26	+ 1.15*	5.68
Disc harrow	4.76	5.57	+ 0.81	5.17
Plough	4.72	6.20	+ 1.48**	5.46
Clean weeding	5.80	6.74	+ 0.94*	6.27
Weeds Slashed	5.61	6.80	+ 1.19**	6.21
Tall weeds	3.18	4.49	+ 1.31**	3.83
Means for cattle manure treatments	4.87	6.01	+ 1.14***	5.44
Least significant differences				
p=0.05	0.88		—	1.19
p=0.01	1.19		—	1.64
p=0.001	1.61		—	2.25

The yields show no overall difference between implements but the greatest response to Athi Plains cattle-manure was obtained from plots weeded by plough, whereas the harrowed plots failed to respond to this treatment.

The presence of tall weeds during the Rains once again reduced the crop substantially, but in 1961 there was no difference between slashing the weeds and full weed control. This may be related to the early cessation of the 1960 Long Rains which resulted in there being no difference in the total weed growth on these plots.

Coffee Research Station: Rotavator Trial

The trial was concluded in 1961 after the eighth crop had been recorded. The design was a 2^3 factorial with two absolute replications and provided for the comparison of the forked hand hoe and a modified "Rotavator" as the weeding implement. The two weeding treatments were the same as the extreme policies in the "Cultivation Trial". Mulching was the third treatment in order to study the effect of this practice on weed suppression and the improvement of soil structure.

TABLE II

Mean annual yields 1954-1961

The interaction of mulch with implements used for clean weeding
(cwt. clean coffee per acre)

Tillage Implement	*No Mulch*	*Alternate inter-row Mulch*	*Response to Mulch*
Forked hand hoe	7.01	7.63	+ 0.62*
Modified rotavator	6.95	8.25	+ 1.30**
Effect of rotavator	—0.06	+0.62*	—

Only the results from the clean weeded plots are given in Table II for, as has been shown in Table I the presence of tall weeds during the Rains leads to a disastrous reduction in the yield of coffee. Where the coffee was unmulched there was no difference between the implements, but provided the ground was mulched and cultivated in alternate years the "Rotavator" was superior to the forked hand hoe. The study of soil structure confirmed these results which are fully described in two papers to be published shortly.

Coffee Research Substation Kitale: Weeding and green manure trial

The importance of weed control was evident from the Cultivation Trial at the Coffee Research Station, and an earlier trial at Kitale had indicated a possible advantage from green manuring. Therefore the following trial was commenced in 1959 to study both practices. The treatments were arranged in a 5 × 5 Latin Square with 18-tree plots surrounded by guard rows. The coffee was spaced at 9 ft. × 9 ft., pruned on a multiple-stem system, and grown under shade. The treatments and the first two years' yields are given in Table III.

TABLE III

Mean annual yields 1960–1961

(cwt. clean coffee per acre)

(assuming cherry: clean coffee ratio of 6:1)

Treatments	1960	1961	1960-1961
Local weeding practice	5.47	5.90	5.69
Weeds slashed	5.67	7.34	6.50
Clean weeding	6.56	6.69	6.63
Green manure—lupins	5.37	5.32	5.35
Green manure—buck wheat	5.55	6.07	5.81
	No significant difference		
Mean	5.72	6.26	5.99
Coefficient of variation%	25.56	28.76	—

The remarkable result of this trial so far is that there is no significant difference between any treatments although the level of cropping is quite good by local standards. There is a trend for the slashed or clean weeded coffee to produce the highest yields, but no precise conclusion will be possible until the effects are greater and the coefficient of variability lower.

IRRIGATION TRIAL

Coffee Research Station: Trial I

This study was begun in 1956 to determine the critical times for coffee irrigation and to compare the efficiency of sprinkler irrigation with ground watering. The progress of the experiment during the first four seasons has been described fully in the Coffee Research Station Report 1959/60 pages 5-11 and explanations were offered for the complete absence of any yield response to irrigation. The crops harvested in 1960 and 1961 revealed substantial yield differences between treatments and,

as all types of recording were intensified during these years, there is now a great wealth of data which enable a full interpretation of the yield results to be made.

Irrigation at each season was sufficient to bring the top ten feet of soil to Field Capacity and these quantities are shown in Table IV, which also defines the timing of the main treatments. The total quantity of irrigation ranged between 3 inches and 21 inches in the 1959/60 season and 8 inches to 17 inches in the 1960/61 period.

TABLE IV

Quantity of Irrigation applied by Overhead Sprinkler from December 1959. Half these quantities were applied to the surface irrigated coffee

(Inches of water)

(i) *Factorially combined treatments*

1959/60	a	December	7.0	—	—	7.0
	b	May/June	—	3.0	—	3.0
	c	August	—	—	9.0	9.0
	a + b		2.5	3.0	—	5.5
	a + c		1.5	—	9.0	10.5
	b + c		—	3.0	6.0	9.0
	a + b + c		1.0	3.0	6.0	10.0
1960/61	a	December	8.0	—	—	8.0
	b	May/June	—	8.0	—	8.0
	c	August	—	—	10.0	10.0
	a + b		8.0	6.0	—	14.0
	a + c		3.0	—	10.0	13.0
	b + c		—	8.0	4.0	12.0
	a + b + c		3.0	6.0	4.0	13.0

(ii) *Treatment extra to the factorial design*

Irrigation to maintain a soil moisture deficit at less than 4 inches per 10 ft. soil profile

X treatment	*Dec.*	*Jan.*	*Feb.*	*March*	*May*	*June*	*Aug.*	*Sept.*	*Totals*
1959/60	1.0	3.0	5.0	—	3.0	—	3.0	6.0	21.0
1960/61	3.0	—	4.0	6.0	—	2.0	2.0	—	17.0

Soil moisture deficits were calculated each ten days for all treatments and these estimates are presented in a condensed form in Table V. All values indicate the number of inches of water required to restore the top ten feet of soil to Field Capacity; a deficit greater than 12 inches indicates that the whole profile is at Wilting Point.

It is evident that the unirrigated coffee was under serious moisture stress for considerable periods during the years 1960 and 1961, whereas the X treatment maintained a ready supply of soil moisture for most of the period. The intention has been to keep the deficits on these plots at less than 4 inches, but practical difficulties early in 1961 resulted in a delay in irrigation so that the deficit was $6\frac{1}{2}$ inches by 1st March. This unintentional moisture stress was apparent in the records of stomatal aperture and provided confirmation of the value of the technique which is reported in more detail on page 56.

TABLE V

Estimated soil moisture deficits on the first day of each month

(The quantity of water in inches necessary to bring the top 10 ft. of soil to Field Capacity.)

1960	(1) Control	6.62	9.09	12.02	7.07	1.03	2.95	5.67	7.10	8.86	10.44	10.05	6.58
	a Dec.	1.35	3.82	6.97	2.02	0.00	2.32	5.04	6.47	8.23	9.81	10.02	6.55
	b May/June	3.08	5.55	8.70	3.75	0.00	0.00	2.89	4.32	6.08	7.66	7.87	4.40
	c Aug.	2.12	4.59	7.74	2.79	0.00	2.32	5.04	6.47	1.71	3.29	3.50	1.58
	a+b	1.35	3.82	6.97	2.02	0.00	2.32	2.54	3.97	5.73	7.31	7.52	4.05
	a+c	1.35	3.82	6.97	2.02	0.00	2.32	5.04	6.47	1.71	3.29	3.50	1.58
	b+c	1.35	3.82	6.97	2.02	0.00	2.32	2.54	3.97	1.71	3.29	3.50	1.58
	a+b+c	1.35	3.82	6.97	2.02	0.00	2.32	2.54	3.97	1.71	3.29	3.50	1.58
	X as necessary	1.35	1.69	2.56	0.00	0.00	0.00	2.89	4.32	4.01	0.94	1.38	1.58

1961	(1) Control	9.13	12.07	12.35	11.71	9.41	7.91	9.45	11.20	12.08	10.99	3.82	0.00
	a Dec.	2.23	6.07	9.26	9.74	7.44	5.94	7.48	9.23	10.42	9.33	0.00	0.00
	b May/June	6.95	10.79	12.13	11.48	9.18	7.68	1.51	3.26	4.45	3.36	0.00	0.00
	c Aug.	4.13	7.97	11.16	11.29	8.99	7.49	9.03	10.78	2.26	1.17	0.00	0.00
	a+b	2.23	6.07	9.26	9.74	7.44	5.94	1.66	3.41	4.60	3.51	0.00	0.00
	a+c	2.23	6.07	9.26	9.74	7.44	5.94	7.48	9.23	0.90	0.31	0.00	0.00
	b+c	4.13	7.97	11.16	11.29	8.99	7.49	1.51	3.26	0.90	0.31	0.00	0.00
	a+b+c	2.23	6.07	9.26	9.74	7.44	5.94	1.66	3.41	0.90	0.31	0.00	0.00
	X as necessary	2.23	6.07	6.56	2.64	0.34	0.08	0.00	1.75	1.23	0.31	0.00	0.00

TABLE VI

Soil Sampling Checks on computed soil moisture deficit

(inches of water per 10 ft. profile)

Soil Sampling Date	*Unirrigated*		*X Irrigation Overhead*		*Coefficient of variation* %
	Estimated	*Measured*	*Estimated*	*Measured*	
18 August 1960 .	8.32	7.85	3.21	3.86	4.98
20 February 1961 .	12.27	10.67	4.96	4.85	2.73

The accuracy of estimates of soil moisture deficit was checked by twice-weekly records of soil moisture block resistance and by occasional direct soil sampling to a depth of 10 feet. In general a very satisfactory agreement was found between the estimated and measured soil deficits, but soil samples drawn from the ground-irrigated coffee generally showed a soil moisture deficit rather greater than estimated. It must be recalled that these plots receive half the volume of water applied by overhead sprinkler, but that it is led to the base of each tree by pipes. Soil samples have been drawn 3 feet from the coffee stems which is approximately the fringe of the surface moistened by ground irrigation.

TABLE VII

Annual yields 1956-1961. Main Treatments

(cwt. clean coffee per acre)

Season of Irrigation	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	Totals.
(1) Nil	9.73	10.97	1.75	19.95	16.22	16.23	74·85
a December	12.75	9.03	1.93	18.24	18.78	12.41	73·14
b June	13.34	9.48	2.67	19.10	16.73	12.94	74·26
ab	9.45	12.92	1.51	18.65	22.63	14.06	79·22
c August	11.80	11.02	1.89	20.12	21.33	15.40	81·56
ac	13.25	10.14	2.42	18.06	22.57	13.50	79·94
bc	12.47	11.41	2.42	20.86	22.36	17.61	87·13
abc	11.67	11.88	2.37	18.13	23.52	13.69	81·26
x as necessary	9.14	11.26	2.06	17.63	27.48	14.99	82·56
Mean	11.51	10.90	2.11	18.97	21.29	14.54	
Coefficient of variation	22.30	19.13	41.78	12.36	18.99	37.18	

The total yield from the unirrigated coffee in 1961 was almost exactly the same as the high yield recorded in 1960, but the percentage of Grade 'A' coffee was far less. The irrigated coffee produced less coffee in 1961 than in 1960, and all the ground irrigation treatments and those irrigated by sprinkler in December yielded significantly less total coffee than the unirrigated coffee. For the two seasons together regular sprinkler irrigation (X) raised the mean annual yield from 16.23 to 23.08 cwt. clean coffee per acre, while ground irrigation at the same frequency gave a yield of 19.39 cwt. All irrigation treatments except ground watering in June raised the mean annual yields significantly, but it was clear that of the three times under study August was the most critical and June the least important. A curious negative interaction was found between December and August irrigation which is summarised in Table VIII for Grade 'A' coffee, though the same effect was apparent in the gross yield of coffee.

TABLE VIII

Mean annual yields 1960–1961

Interaction of December and August Irrigations

(cwt. Grade 'A' coffee per acre)

Irrigation in August	*Irrigation in December*		*Response to December Irrigation*
	Without	*With*	
Without	4.31	5.20	+0.89
With	6.76	6.18	−0.58
Response to August Irrigation	+2.45	+0.98	—

It may be seen that December irrigation has reduced substantially the response to irrigation in August, while the earlier irrigation has reversed the effect of the later.

The results of greatest economic importance are the effects of irrigation on coffee quality. This has been studied by determining the yield of Grade 'A' coffee and by the submission of samples for evaluation by the Liquorer of the Coffee Marketing Board.

The right-hand side of Table IX reveals that in 1961 all sprinkler irrigation treatments markedly raised the yield of Grade 'A' ($p = 0.001$), which was an effect in no way apparent from the gross yields shown in the left-hand side of the table. The importance of the August irrigation is further

emphasised and sprinkler irrigation is shown to be superior to ground watering; this was particularly evident in the (X) treatment.

Reports on the raw, roast and liquor were obtained from fully replicated samples processed from coffee picked from the early, middle and late part of the 1960 and 1961 picking seasons. Only Grade 'A' coffee was submitted for assessment, and in no case did it prove possible to distinguish the irrigated from the unirrigated coffee or detect differences between the irrigation treatments. It appears therefore that so far only the Grade 'A' or bean size determinations can provide a useful index of the effect of irrigation on coffee quality.

TABLE IX

Annual yields 1960–1961

Method of Irrigation

(cwt. coffee per acre)

Irrigation Method	*Main Treatments*	*Gross Yield*			*Grade 'A' Coffee*			
		1960	*1961*	*1960–1961*	*1960*	*1961*	*1960–1961*	
							Yield	%
	(1) Nil	16.22	16.23	16.23	6.14	2.36	4.25	26.19
Sprinkler	+A December	21.92***	14.07**	18.00***	8.46***	3.46***	5.96	33.11
	+B June	21.72***	15.74	18.73***	8.50***	3.91***	6.20	33.10
	+C August	23.00***	15.79	19.40***	8.94***	4.81***	6.87	35.41
	X as necessary	29.24***	16.91	23.08***	14.73***	6.01***	10.37	44.93
Ground	+A	21.82***	12.76***	17.29*	8.29***	2.52	5.41	31.29
	+B	20.90***	13.41***	17.16	7.99***	2.88	5.44	31.70
	+C	21.89***	14.31*	18.10***	8.54***	3.59***	6.07	33.54
	X	25.71***	13.07***	19.39***	10.98***	4.21***	7.60	39.20
Means	+A	21.87***	13.42***	17.65**	8.38***	2.99*	5.69	32.24
	+B	21.31***	14.58*	17.95***	8.24***	3.40***	5.82	32.42
	+C	22.45***	15.05	18.75***	8.74***	4.20***	6.47	34 51
	X	27.48***	14.99	21.24***	12.85***	5.11***	8.98	42.28
Overall means		21.29	14.54	17.92	8.47	3.50		
Coefficient of variation % . .		12.09	32.77	17.52	24.28	40.82		

Significance of differences from the yield of unirrigated coffee *p=0.05; **p=0.01; ***p=0.001

During 1960 monthly leaf samples were collected from selected treatments and analysed chemically for nitrogen, phosphorus and potassium. Material was then sent to the East African Agricultural and Forestry Research Organisation at Muguga for spectrographic analysis by a member of the Coffee Research Service staff. This provided information on a further 16 elements. The principal finding was that, except for the wet months of May and November, the phosphorus in the leaves from irrigated coffee was considerably more than that found for unirrigated coffee, e.g. October 1960, irrigated 0.1485% P.; unirrigated 0.1059% P. This provided striking confirmation of the view that under local conditions phosphorus nutrition of coffee is closely related to soil moisture status and its apparent deficiency at certain seasons may be more effectively corrected by improving moisture conditions than by applying any phosphorus fertilizer.

Throughout 1960 and 1961 the incidence of Leaf Rust was regularly recorded to compare the influence of sprinkler and ground methods of irrigation on the incidence of the disease. The whole trial was treated with copper fungicide sprays as currently recommended to coffee growers, and these were effective in controlling Leaf Rust on all irrigation treatments. There is therefore no indication that sprinkler irrigation will induce severe Rust attack provided the coffee receives well-applied protective copper sprays at the same time as unirrigated coffee.

1961 was the last year of a multiple-stem pruning cycle on this trial, therefore new suckers were allowed to develop from August 1961. Their initial growth was poor because the foliage on the old heads was so dense and, on the irrigated coffee, the crop was not off the trees until early November. The following investigation was then carried out to study the effect of irrigation on foliage density and weight while developing a technique for estimating the number of leaves on multiple-stem coffee trees:—

Five primaries were chosen on each of two stems per plot of which there were 108. The lowest primary was Number 1, the highest Number 5 and the others were evenly disposed in the intervening section of the stem. On each primary the number of secondaries was counted and the leaves growing on primary and secondary wood were separately recorded. There was no significant difference between the treatments although there was a distinct trend for higher numbers of leaves on the plots receiving nitrogen fertilizer.

TABLE X

Measurements of vegetative development

	Number of Determinations	*General Mean*				*Coefficient of variation*
Vertical extension Dec. 1959–Nov. 1960 . .	3,240 stems	19.85 cm.				11.28%
Number of secondaries and leaves on 5 primaries per stem Nov. 1961	216 stems					
Number of secondaries . .		23				24.91%
Leaves on secondary wood. .		350				33.36%
Leaves on primary wood . .		80				11.29%
Total number of leaves . .		430				27.23%
		−N	*+N*	*N effect*	*General Mean*	
Weight of stem and leaves one stem per tree Nov./Dec. 1961 .	1,080 stems					
Fresh weight/stem without leaves Kg.		4.72	5.17	+0.45**	4.95	14.44%
Fresh weight of leaves/stem Kg.		3.95	4.29	+0.34**	4.12	14.95%
Dry weight of leaves/stem mean dry matter 40% Kg. . .		1.580	1.716	+0.136	1.684	
Dry weight of leaves/tree 3 stems/tree Kg. . . .		4.740	5.148	+0.408	5.052	

In the course of pruning one of the three stems on each tree was sawn off 3 feet from the ground. All the heads removed were weighed immediately after being cut off and then weighed again after every leaf had been removed by hand. Concurrent leaf sampling for carbohydrate determinations provided a value for the percentage of dry matter in the leaves, therefore the dry weight of leaves could be estimated. This work revealed no significant difference between irrigation treatments, but showed that the nitrogen fertilizer treatment had raised the fresh weight of wood and leaves per stem. These differences were quite substantial for as may be seen in Table X the fertilizer increased the dry weight of leaves per tree by 408 gms.

It had been hoped to estimate leaf numbers from the dry weight of leaves, but several determinations gave such variable results that such a deduction is not yet possible. It appears however that an acre of thickly foliaged coffee plantation will have about eight or nine acres of leaf and that there would be between 15,000 and 20,000 leaves per tree.

The numbers of leaves on the selected primaries were then compared with the fresh weight of all the leaves removed from the same stem. This analysis was carried out by the Statistician of the Agricultural Department who showed that a logarithmic transformation was appropriate to the study of leaf number. The leaf numbers on the lowest primary (Number 1) were then compared with the total fresh weight of leaves, then the number of leaves on the two lowest primaries (Number

1 and Number 2) were compared with the fresh weight. Other similar analyses were made and the correlations may be summarised as follows:—

Highest Primary Number					5	
				4	4	
			3	3	3	
		2	2	2	2	
Lowest Primary Number	1	1	1	1	1	
Correlation of total fresh weight of leaves per stem with Log. leaf number per primary.	0.320	0.363	0.355	0.321	0.359	all highly significant. No significant difference between correlations.

These results indicate that, provided a large number of primaries is counted, it is not important at which height on the tree the leaves are counted in order to estimate the weight of leaves per tree.

CATTLE MANURE, FERTILIZER AND MULCH TRIALS

Coffee Research Station: Trial I

This was a complex factorial trial laid down in 1947 to study the effect on coffee of applications of nitrogen, phosphorus and cattle manure. After the 1951 crop had been recorded the trial was reduced to three replications of a 3^2 factorial design by reducing the area of the trial and omitting the phosphorus treatments which had been found quite ineffective. This experiment was described in detail in the Coffee Research Station Report 1956/57 pages 21-24. Since 1957 the trial has been designed to compare the efficiency of ammonium sulphate and urea in the presence of three levels of cattle manure application.

TABLE XI

Mean annual yields 1947-1961

(cwt. clean coffee per acre)

Annual Applications	N_0 *Nil*	N_1 *23 lb. nitrogen per acre*	N_2 *46 lb. nitrogen per acre*	C_0 *Nil*	C_1 *1×4 gall. tin manure per tree*	C_2 *2×4 gall. tin manure per tree*	*General Mean*	*Least significant difference* p=0.05	p=0.01	p=0.001
1947–1951 .	4.44	4.47	4.75	4.66	4.52	4.48	4.55	0.25	0.33	
1952–1956 .	7.38	7.83	8.34	7.75	7.71	8.09	7.85	0.27	0.38	
1961 . .	4.42	—	5.51	4.69	5.19	5.80	5.23	0.92	1.27	1.75
1951–1961 .	8.79	—	9.84	9.06	9.05	9.77	9.29	0.50	0.69	0.94
Mean yield 1951–1961 Grade 'A' .	3.19	—	3.84	3.32	3.48	3.60	3.47	0.33	0.46	0.63

Over the 11 years 1951 to 1961 an annual application of 2 cwt. ammonium sulphate (46 lb. nitrogen) raised the mean annual yield by just over 1 cwt. of clean coffee per acre (p=0.001) and of this increase 0.65 cwt. was Grade 'A' coffee. During this same period an annual application of one tin of manure per tree had little effect but at two tins per tree the mean annual yield was raised by 0.71 cwt. of clean coffee per acre (p=0.01).

TABLE XII

Mean annual yields 1957-1961

(cwt. clean coffee per acre)

Annual applications / *Fertilizer per acre*	*Cattle manure per tree*			*Means for nitrogen fertilizer*	*Least significant differences*		
	C_0 *Nil*	C_1 *1×4 gall.*	C_2 *2×4 gall.*		p=0.05	p=0.01	p=0.001
N_0 Nil	8.92	9.05	10.46	9.48 100%			
N_1 46 lb. nitrogen as urea	9.25	9.97	10.91	10.04 106%	*Within the table* 1.19	1.64	2.26
N_2 46 lb. nitrogen as ammonium sulphate	10.40	10.02	11.43	10.62 112%			
Means for cattle manure	9.52 100%	9.68 102%	10.94 115%	10.05 —	*Between marginal means* 0.69	0.95	1.30
Mean % Grade 'A'	35.29	37.81	38.48	37.21	—	—	—
Mean yield Grade 'A'	3.36 100%	3.66 109%	4.21 125%	3.74 —	0.40	0.56	0.77

During the past five seasons 1957 to 1961 the application of two tins of manure per tree each year raised the total yield of coffee by 15% and the Grade 'A' yield by 25%; both of these effects are statistically very highly significant. From Table XII it may be seen that urea has failed to raise the yield of coffee significantly, while a modest response is shown to the annual application of 2 cwt. ammonium sulphate per acre (p=0.01). In view of recent research results from other crops it should be emphasised that neither fertilizer was worked into the top-soil as is now suggested for urea applications.

Coffee Research Station: Trial II

The early phase of Manurial Trial I had shown low or no responses to the rates of fertilizer and manure tested, therefore Trial II was laid down in 1950 to study rates double the highest in the earlier experiment.

TABLE XIII

Mean annual yields 1950–1961

(cwt. clean coffee per acre)

Annual Treatments	*1950-1961*	*1951-1961*	
	Gross Yield	*Grade "A" Yield*	*% of total*
Nitrogen			
Nil	7.37	2.44	31.39
92 lb./acre	9.45	2.95	29.87
Response	+2.08**	+0.51**	
Phosphorus			
Nil	8.73	2.74	29.94
92 lb. Citric Soluble P_2O_5/acre	8.09	2.65	31.17
	No significant difference		
Cattle Manure			
Nil	8.47	2.62	29.54
4 tin/tree	8.35	2.77	31.54
	No significant difference		
Mean	8 41	2.70	
Coefficient of variation %	10.78	7.29	

Twelve years' results serve to confirm the earlier finding that under local conditions mature coffee does not respond to phosphorus applications. As has been mentioned in reporting the Irrigation Trial (page 9), soil moisture status and phosphorus nutrition are closely related, therefore the main plots of this trial were split in 1961 to compare the responses to the fertilizer and manure treatments in the presence and absence of mulch.

At the rate of 92 lb. nitrogen per acre the response to this nutrient has been approximately double that shown for 46 lb. nitrogen in Table XI, however it is clear that in Trial II some of this increase has been at the expense of bean size as indicated by the percentage of Grade 'A' coffee.

It is remarkable that four tins manure applied to each tree for 12 years had had no effect on the yield of coffee.

Coffee Research Station: Trial IV

The main object of this experiment has been to investigate the interaction of nitrogen fertilizer response and the effects of mulching. The higher rate of fertilizer application is equivalent to 6 cwt. of ammonium sulphate per acre, but ammonium sulphate nitrate was used in 1960 and 1961.

TABLE XIV

Mean annual yields 1954–1961

(cwt. clean coffee per acre)

Annual application per acre	*No. mulch*	*Mulch applied in March*			*Means for fertilizer treatments*
		6 ft. strip alternate inter-rows	*4½ ft. strip every row*	*6 ft. strip every inter-row*	
Nil					
N_0 total yield	8.99	10.02	9.90	10.04	9.74
Grade 'A' yield	3.92	4.64	4.54	4.25	4.34
Grade 'A' %	43.60	46.31	45.86	42.33	44.56
69 lb. nitrogen					
N_1 Total yield	9.50	11.65	11.24	11.25	10.91
Grade 'A' yield	3.92	5.46	5.09	5.09	4.89
Grade 'A' %	41.26	46.87	45.29	45.24	44.82
138 lb. nitrogen					
N_2 Total yield	9.97	10.32	12.21	10.52	10.76
Grade 'A' yield	4.13	4.30	5.51	4.33	4.57
Grade 'A' %	41.42	41.67	45.13	41.16	42.47
Means total yield	9.49	10.66	11.12	10.60	10.47
Grade 'A' yield	3.99	4.80	5.05	4.56	4.60
Grade 'A' %	42.04	45.03	45.41	43.02	43.94
Least significant differences	*Within the table*	*Between nitrogen treatments*	*Between mulch treatments*		
Total yield					
p = 0.05	1.40	0.70	0.81		
p = 0.01	1.88	0.94	1.08		
p = 0.001	2.48	1.24	1.43		
Grade 'A' yield					
p = 0 05	0.86	0.43	0.50		
p = 0.01	1.15	0.58	0.66		
p = 0.001	1.52	0.76	0.88		

The main treatments and mean annual yield for the eight years of this trial are given in Table XIV. Both rates of fertilizer raised the yield of clean coffee by about 1 cwt. per acre, which is similar

to the response to 46 lb. nitrogen per acre shown in Table XI. Furthermore, without mulch the nitrogen fertilizer has slightly reduced the percentage of Grade 'A' coffee. There was no difference in overall effect of the three mulch treatments, though all significantly raised the total yield of coffee as well as the production of Grade 'A' beans.

For the nitrogen treatment supplying 138 lb. nitrogen per acre the in-row mulch application was clearly more effective than either inter-row treatment ($p=0.05$), but the combination most attractive economically was 69 lb. nitrogen per acre and alternate inter-row mulching. This pair of treatments raised mean annual yields by $2\frac{2}{3}$ cwt. of clean coffee per acre of which $1\frac{1}{2}$ cwt. was Grade 'A' coffee.

TABLE XV

Mean annual yields 1954–1961

The influence of nitrogen placement on the response of mulched coffee to nitrogen fertilizers

(cwt. clean coffee per acre)

Annual application per acre	*Fertilizer placement*		*Mulched coffee without fertilizer*
	To bare soil	*Over the mulch*	
N_0 Nil	—	—	9.99
N_1 69 lb. nitrogen . .	+1.39**	+0.32	—
N_2 138 lb. nitrogen . .	+1.03*	+0.77	—

The importance of fertilizer placement has become increasingly clear in this trial which has shown that nitrogen fertilizer must be applied to the bare soil and not scattered over a layer of mulch. This is an added reason for advocating alternate inter-row mulching as this method facilitates the

TABLE XVI

Mean annual yields 1959-1961

(cwt. clean coffee per acre)

Annual Application per acre	*1959*	*1960*	*1961*	*1959-1961*
Magnesium				
M_0 Nil	9.12	9.53	8.77	9.14
M_1 25 lb Mg.	8.18	9.48	8.54	8.74
M_2 50 lb Mg.	8.39	9.42	8.46	8.76
M_3 100 lb Mg.	8.00	10.81	8.94	9.25
	No significant difference			
Nitrogen				
N_0 Nil	7.92	11.30	8.62	9.28
N_1 46 lb N	8.64	9.02	8.05	8.57
N_2 92 lb N	8.71	9.08	9.36	9.05
Calcium				
−Ca Nil	8.46	10.07	8.64	9.06
+Ca 112 lb hydrated lime	8.38	9.53	8.72	8.88
Mulch				
− Nil	7.20	7.61	7.25	7.35
+ Alternate inter-row	9.64	12.00	10.11	10.59
General Mean	8.42	9.80	8.68	8.97
Coefficient of variation %	18.94	18.87	20.28	16.53

rapid and efficient distribution of fertilizers which may be applied mechanically along the umulched inter-rows.

Coffee Research Station: Trial V

The trial was laid down on one-year-old coffee in 1957 to study the effects of mulching on the magnesium and calcium nutrition of coffee trees. The design of the experiment enables the study of various interactions, but is less sensitive to main effects; however as no interaction attains statistical significance only main effects are reported in Table XVI.

The magnesium, nitrogen and calcium treatments have all failed to affect the mean annual yields for the three years this trial has been recorded, but in each season there has been a substantial response to mulch. In view of the great interest in the interaction between mulch and magnesium this information is given in Table XVII.

TABLE XVII

Mean annual yield 1959-1961
Mulch × Magnesium Fertilizer Interaction
(cwt. clean coffee per acre)

Annual application per acre		*No Mulch*	*Alternate Inter-row Mulch*	*Effect of Mulch*	*Level of Signi-ficance*
M_0	Nil Mg	8.08	10 20	+2.12	p=0 05
M_1	25 lb Mg.	6.57	10 90	+4.33	p=0 01
M_2	50 lb Mg.	7.06	10.45	+3.39	p=0 01
M_3	100 lb Mg.	7.69	10.81	+3.12	p=0 01
Overall mulch effect		7.35	10.59	+3.24	p=0.001

It would appear at first that the response to mulching has been enhanced by the addition of magnesium, but this may be partly attributed to the tendency to lower yields where magnesium fertilizers have been applied to unmulched coffee.

Coffee Research Station: Trial VI

In 1957 this trial was designed to compare kieserite and calcined magnesite as magnesium fertilizers for mature and well-mulched coffee. Each material was tested at three rates and in combination so that the full range of treatment tested the effect of annual additions of 20, 40, 60 and 80 lb. magnesium per acre.

TABLE XVIII

Mean annual yields 1958-1961
(cwt. clean coffee per acre)

Annual Application per acre (lb.)		*Gross Yield*	*Grade 'A' Yield*	*Grade 'A' %*
Calcined magnesite	*Magnesium*			
0	0	11.90	4.36	36.64
45	20	10 65	3.82	35 87
90	40	12.15	4.45	36.63
		No significant difference		
Kieserite				
0	0	11.64	4.25	36.51
112	20	11 54	4.19	36 31
224	40	11 52	4.19	36.37
		No significant difference		
Mean		11 57	4.21	36.39
Coefficient of variation %		11.67	14.13	—

Neither in individual years, nor in the aggregate analysis for the four seasons was there any significant difference betwen treatments in terms of total coffee or yield of Grade 'A' beans.

Coffee Research Station: Trial VIII

The trial was designed to test nitrogen fertilizer rates of up to 160 lb. nitrogen per acre applied in one, two or three doses a year during the two seasons of Rains. The foliar application of nitrogen in the dry weather is also examined as monthly or bimonthly sprays of 1% urea during the period. May to October.

Two crops have now been recorded, but there is no clear effect of any treatment or group of treatments on the yield of coffee.

Coffee Research Station: Trial IX

Seven nitrogen fertilizers are compared in the presence or absence of mulch in a trial which was commenced in 1960. Each fertilizer is used at a rate to supply a total of 100 lb. nitrogen per acre in three equal doses applied in April, May and November.

TABLE XIX

Mean annual yields 1960-1961

(cwt. clean coffee per acre)

Three equal annual applications April/May, November to total 100 lb. nitrogen/acre	*Form of nitrogen*		*1960*	*1961*	*1960-1961*		
	Nitrate %	*Ammonium* %	*Clean Coffee Yield*	*Clean Coffee Yield*	*Clean Coffee Yield*	*Grade 'A' Yield*	*Grade 'A'* %
A Control	0.0	0.0	10.10	8.80	9.45	3.29	34 82
B Sodium nitrate	16.0	0.0	11.68	9.74	10.71	4.07	38.00
C Calcium nitrate	15.5	0.0	12.50	10.58	11.54	4.40	38.13
D Calcium ammonium nitrate	10.5	10.0	12.02	10.38	11.20	3.83	34.20
E Ammonium sulphate nitrate	6.5	19.5	12.18	10.05	11.12	3.91	35.16
F C D — Urea (1961 only)	2.8	25.2	(11.98)	9.72	10.85	4.26	39.26
G Ammonium sulphate	0.0	20.5	12.00	10.69	11.35	3.92	34.54
H Urea	0.0	46.0	11.41	9.52	10.46	3.96	37.86
General mean			11.73	9.94	10.84	3.96	36.53
Least significant difference p = 0.05			2.39	2.05	2.09	1.10	—

The results for 1960 and 1961 are summarised in Table XIX which shows that only calcium nitrate raised the mean annual yield significantly by 2.09 cwt. ($p=0.05$). Previous trials have revealed distinct interaction between mulch and the form of nitrogen fertilizer. This aspect of the trial is therefore presented in Table XX.

Without mulch only fertilizers in which both ammonium and nitrate nitrogen are present raised the yield of coffee significantly, whereas with mulch there is a suggestion that the nitrate form has been the most efficient. This would contradict an earlier result from the next trial to be reported and the trend must be regarded with caution.

Coffee Research Station: Mulch and soil regeneration trial

Although initially laid down in 1949, this trial was not in full operation until 1951 when the fertilizer treatments were first applied. From 1951 the layout has been of a $4\times4\times2$ factorial design which is analysed as a 2^5 factorial. The 20-tree plots are grouped blocks of eight and there are three interactions confounded in the two replications. In 1956 the plots of the first full replication were subdivided once to allow the testing of a magnesium fertilizer. In 1958 the cattle manure treatment was replaced by two severities of pruning and in 1959 ammonium sulphate nitrate was used for the

TABLE XX

Mean annual yields 1960-1961
Interaction of Mulch with Fertilizer Type
(cwt. clean coffee per acre)

Forms of Nitrogen		*Without mulch*			*With mulch*			*Effect of mulch*		
		Yield		%	*Yield*		%	*Yield*		%
		Total	*Grade 'A'*		*Total*	*Grade 'A'*		*Total*	*Grade 'A'*	
No nitrogen fertilizer	A	7.57	2.27	29.99	11.34	4.30	37.92	+3.77	+2.03	+89.43
Nitrate form alone	B,C	9.76	3.47	35.55	12.49	5.00	40.03	+2.73	+1.53	+44.09
Nitrate and ammonium forms	D,E	10.52	3.45	32.79	11.80	4.29	36.36	+1.28	+0.84	+23.35
Ammonium form alone	G,H	10.08	3.39	33.63	11.73	4.49	38.28	+1.65	+1.10	+32.45
		Responses to fertilizers						*Responses to mulch*		
Least significant difference =										
p = 0.05		2.56	1.35	—	2.56	1.35	—	2.95	1.56	—
p = 0.01		3.42	1.80	—	3.42	1.80	—	3.95	2.08	—

first time in the treatment which is designated as "½ ammonium and ½ nitrate" nitrogen although the proportion is in fact 3:1. Ammonium sulphate has been used as the ammonium and sodium nitrate as the nitrate source throughout the trial. For the three seasons 1951–1953 all fertilizer treatments were applied at rates to supply 23 lb. of nitrogen per acre in one application early in the Long Rains (April). From 1954 the rates were doubled and from 1960 this quantity was divided equally between dressings applied about the middle of April and one month later.

TABLE XXI

Mean annual yields 1950-1961
Mulch treatments
(cwt. clean coffee per acre)

Mulch Treatments	*1950-1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1957-1961*	*1950-1961*
No mulch	7.45	11.69	4.79	12.31	6.78	8.15	8.74	7.99
Alternate inter-rows pre Long Rains	9.13	7.39	6.56	15.32	11.17	9.80	10.05	9.51
All inter-rows pre Long Rains	9.76	5.45	7.79	16.55	13.59	8.82	10.44	10.04
All inter-rows post Long Rains	9.56	5.89	6.73	14.77	13.03	8.79	9.84	9.68
Mean	8.98	7.61	6.47	14.74	11.14	8.89	9.77	9.31
Least significant difference								
p = 0.05	0.53	1.85	1.13	0.94	1.36	0.95	0.50	0.46
p = 0.01	0.72	2.49	1.53	1.27	1.83	1.28	0.67	0.61
p = 0.001	0.96	3.31	2.03	1.69	2.44	1.70	0.89	0.82

It is with remarkable consistency that all mulch treatments have raised the yield of coffee. In occasional years, such as 1955 or 1957, the unmulched coffee considerably outyielded the mulched, but as was shown in Coffee Research Station Report 1957/58 page 10, this may be the result of misjudgments in pruning resulting in biennial bearing being more marked on one or other of the treatments. Over the 12 seasons 1950-1961 the mean annual response to alternate inter-row mulching has been to raise the yield by 1⅓cwt. clean coffee per acre, while a 2-cwt. response is shown in Table XXI as a result of mulching between all rows of coffee before the onset of the Main Rains. The same quantity of mulch applied after the Rains was rather less effective and indeed no more productive than the pre-Rains alternate inter-row treatment. The benefit of all inter-row mulching lies principally in that this treatment produces a far better bean size that alternate inter-row mulching. (Coffee Research Station Annual Report 1959/60 page 25).

TABLE XXII

Mean annual yields 1951-1961
Fertilizer treatments
(cwt. clean coffee per acre)

Nitrogen fertilizer	*1951-1958*	*1957*	*1958*	*1959*	*1960*	*1961*	*1957-1961-*	*1951-1961*
No fertilizer	9.80	7.57	6.60	14.23	10.79	7.70	9.38	9.60
Ammonium form	10 38	8.57	6.81	14.70	12.01	9.42	10.30	10.34
Nitrate form	10.76	7.03	6.67	15.40	10.36	9.41	9.77	10.31
½ Ammonium ½ Nitrate form	10.28	7.26	5.79	14.63	11.41	9.03	9.62	9.98
Mean	10.31	7.61	6.47	14.74	11.14	8.89	9.77	10.06
Least significant difference								
p = 0.05	0.64	1.85	1.13	0.94	1.36	0.95	0.50	0.66
p = 0 01							0.67	0.89
p = 0.001							0.89	1.18

Responses to nitrogen fertilizers are not regular but can be quite considerable as in 1961. During the pruning cycle which covered the five seasons 1957 to 1961 2 cwt. of ammonium sulphate per acre raised the mean annual yield by 1 cwt. of clean coffee per acre ($p=0.001$), but the other fertilizers failed to raise the yield significantly where the coffee was mulched.

Coffee Research Substation Kitale: Mulch and nitrogen fertilizer trial

The results of this experiment are in marked contrast to those of the Coffee Research Station mulch and fertilizer trials at Ruiru. The present trial was laid down in 1956 in a 5×5 Latin Square design with 20-tree plots under shade and pruned according to a multiple-stem system. The treatments are as follows:—

A. No mulch or fertilizer

B. 92 lb. nitrogen per acre as Calcium ammonium nitrate (C.A.N.)
224 lb. C.A.N. in April/May
224 lb. C.A.N. in August/September

C. Mulched with Napier grass applied in October

D. Mulched with Napier grass applied in October
46 lb. nitrogen per acre
224 lb. C.A.N. in April/May

E. Mulched with maize stover in January.

TABLE XXIII

Mean annual yields 1956-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Treatment	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1956-1961*
A Control	6.70	6.43	5.23	10 02	6.56	8.88	7.30
B Nitrogen	5.46	6.61	4.77	9.74	5.65	8.12	6.73
C Napier mulch	6.02	6.61	5.46	9.54	7.56	8.38	7.26
D Napier mulch + Nitrogen	7.22	6.30	5.28	9.56	7.88	9.46	7.62
E Maize stover mulch	7.04	6.20	5.29	9.58	7.39	8.68	7.36
			No significant difference				
Mean	6.49	6.43	5.20	9.69	7.01	8.70	7.25
Coefficient of variation %	—	27.29	26.52	10.20	28.01	18.32	—

Despite a reasonable level of variability no difference of statistical significance could be detected in any year or in the aggregate over the full six seasons.

Coffee Research Substation Kitale: Mulch, nitrogen and magnesium fertilizer trial

In 1959 this trial was laid down on coffee planted two years earlier and the first small crop was recorded in 1961. The treatments were designed to investigate further the effects of medium and high rates of nitrogen application in the presence and absence of mulch and a magnesium fertilizer. These were combined in a $4\times2\times2$ factorial design with 16-tree plots.

TABLE XXIV

1961 yields

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Magnesium every 3 years in March	*Mulch*		*Mean*		*Least significant difference*	
	Nil	*Alternate inter-rows September*			*within the table*	*between marginal means*
Nil	2.40	3.48	2.94	p=0 05	0.93	0 65
2 cwt. Calmag	2.98	3.64	3.31	p=0.01	1.28	0.90
Mean	2.69	3.56	3.13			

The first crop revealed a distinct response to mulch but none to nitrogen or magnesium fertilizers. It appears that mulch is important to young coffee at Kitale although the previous trial on mature and well-shaded trees showed no advantage from the practice.

Coffee Research Substation Kisii: Mulch, nitrogen and magnesium fertilizer trial

The main treatments of this experiment form a 4^2 factorial combination designed to study the timing of mulch and nitrogen fertilizer applications. There are four absolute replications of the treatments which were first applied in 1959 and the 20-tree main plots are split once to test the biennial application of 2 cwt. of calcined magnesite ("Calmag") per acre.

TABLE XXV

1961 yields

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Nitrogen treatments	*Mulch Treatments*				*Means for Nitrogen treatments*
	No Mulch	*Alternate inter-rows*		*Total ground cover*	
		March	*October*		
No nitrogen	2.76	3.80	3.55	4.36	3.62
46 lb. N/acre April	3.26	2.99	3.52	3.97	3.43
46 lb. N/acre August	2.52	2.85	3.60	2.91	2.97
23 lb. N/acre April } 23 lb. N/acre August }	2.99	4.01	3.02	3.91	3.48
Means for mulch treatments	2.88	3.41	3.42	3.79	3.38
Coefficient of variation %	*No significant difference*				25.26

The first crop from this young coffee was picked in 1961. Unlike the trial at Kitale, in this experiment the response to mulch did not attain statistical significance, although it may be seen in Table XXV that there was a clear trend in favour of mulching. There was no indication of any benefit from the use of nitrogen or magnesium fertilizers.

Coffee Research Substation Upper Kiambu: Cattle manure, nitrogen and magnesium fertilizer trial

In 1959 this trial was laid down to study the fertilizer treatments shown in Table XXVI and assess the value of applying six 4-gallon tins of cattle manure per tree every three years. The coffee had been planted many years earlier at a spacing of 10 ft. × 10 ft. on the triangle and was shaded by rather irregularly spaced *Grevillea robusta* trees. The coffee was converted from a single- to multiple-stem system of pruning during 1959 and 1960 so that the first full crop was recorded in 1961.

TABLE XXVI

Annual yields 1959-1961

(cwt. clean coffee per acre)

Nitrogen fertilizer treatments	*1959*	*1960*	*1961*	*1959-1961*			
				Without manure	*With manure*	*Mean*	*Grade 'A' %*
No nitrogen	1.05	3.12	9.42	4.11	4.95	4.53	43.49
92 lb. nitrogen/acre April	0.90	3.20	10.72	4.85	5.03	4.94	47.98
46 lb. nitrogen/acre April; 46 lb. nitrogen/acre May	1.28	3.92	12.71	5.95	5.98	5.97	53.10
92 lb. nitrogen/acre April; 89 lb. magnesium/acre March	1.30	3.04	9.94	4.67	4.84	4.76	48.74
Mean	1.13	3.32	10.70	4.90	5.20	5.05	48.71
Coefficient of variation %		21.19	17.94			12.39	
Least significant difference p=0.05		0.73	2.00	0.92		0.65	
p=0 01		1.00	2.72	1.25		0.89	
p=0.001		1.34	3.67	1.69		1.19	

Both in 1960 and 1961 the application of 177 lb. per acre of ammonium sulphate nitrate in April and again in May significantly raised the yield of coffee. 354 lb. per acre of the same fertilizer applied in April was ineffective, therefore it would appear that May is a more important time than April for the application of this fertilizer to coffee in Upper Kiambu. This is the first clear indication that shaded coffee in Kenya will respond significantly to the ground application of a nitrogen fertilizer,

and, as is shown in the last column of Table XXVI, this treatment has also raised the proportion of Grade 'A' coffee by nearly 10%. There has been no response to the heavy application of manure in 1959 but there are indications that this may develop in the absence of any nitrogen fertilizer. It appears probable that the manure will not enhance any response to the fertilizer.

Agricultural Investigation Centre Embu: Cattle manure trial

This trial was initiated in 1958 to determine the value of cattle manure to the establishment and early development of young coffee. Before planting in November 1958 the planting site for each tree received two 4-gallon tins of cattle manure, thereafter the treatments have been those shown in Table XXVII. Treatment E will continue to receive one tin of manure per tree each year until the trial is concluded.

TABLE XXVII

1961 yields

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Cattle manure treatments after planting Nov. 1958	
A Nil	3.31
B 1 × 4 gall. tin per tree in 1959	1.76
C " " " 1959 and 1960	1.63
D " " " 1959, 1960 and 1961	2.54
E " " " 1959, 1960 and 1961	3.35,
	No significant difference
Mean	2.52
Coefficient of variation %	37.69

The five treatments are grouped in randomised blocks and replicated four times. Each plot consists of ten trees spaced at 9 ft. × 9 ft. and pruned on a multiple-stem system.

The first crop was recorded in 1961 but the yields were low and revealed no difference of statistical significance.

Agricultural Investigation Centre, Embu: Mulch and copper spray trial

The trial was laid down in 1958 on coffee which had been planted in 1955 at a spacing of 9 ft. × 9 ft. on bench terraces and had subsequently been pruned on a multiple stem-system.

The mulch treatments are described in terms of the proportion of ground covered and these are applied before the Long Rains. The copper spray treatment is designed to improve leaf retention and is carried out each May. The spray liquid contains 6.8 lb. of a 50% copper fungicide per 100 gallons of water and is applied at the rate of between 1 and 2 pints per tree.

TABLE XXVIII

Mean annual yields 1958-1960

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Mulch treatments	*Copper spray in May*		*Response to Spraying*	*Means for Mulch Treatments*
	No copper spray	*Copper spray*		
No Mulch	13.68	13.73	+0.05	13.71
33% ground cover	12.56	15.28	+2.72*	13.92
66% ground cover	14.01	16.09	+2.08	15.05
100% ground cover	13.01	15.41	+2.40*	14.21
Means for spraying treatments	13.32	15.13	+1.81**	14 22
Coefficient of variation %				10.70
Least significant difference p=0.05		2.22		1.57

In 1961 there was no crop recorded from the trees of this trial, but from the mean annual yields for the three seasons 1958 to 1960 the results are quite clear. Coffee unsprayed in May failed to respond to any mulch treatment and the copper spray has been ineffective on unmulched coffee. For coffee receiving regular copper sprays each May the two-thirds ground cover of mulch was the only one significantly to raise the yield of coffee.

COPPER SPRAY TRIALS FOR THE REDUCTION OF LEAF FALL

Coffee Research Substation, Kitale

The main object of this experiment has been to discover the optimum time for spraying with a copper fungicide, however the 4 × 2 × 2 factorial design of the trial also allows for the comparison of two volumes and two rates of fungicide application. The combination of these latter treatments results in rates of fungicide of 2.14, 4.28, 6.42 and 12.84 lb. per acre. The times of spraying and the yields since the trial began are summarised in Table XXIX.

TABLE XXIX

Annual yields 1952-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Copper spray timing	*1952*	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1953-1961*
No spray	7.49	6.38	8.22	6.87	5.21	6.25	1.59	8.53	5.62	9.86	6.50
May	7.53	8.27	10.40	10.38	6.65	7.81	1.89	9.66	6.65	9.55	7.92
June	7.77	7.14	10.48	8.46	7.73	7.27	2.64	9.46	7.82	13.31	8.25
August	7.79	6.30	11.68	5.99	8.00	6.69	1.95	8.90	6.31	13.07	7.65
Mean	7.65	7.02	10.19	7.92	6.90	7.00	2.02	9.14	6.60	11.45	7.58
Coefficient of variation %	15.85	15.39	26.33	24.20	15.85	22.66	37.70	13.15	11.36	27.05	
Least significant difference											
p = 0.05		0.90	2.24	1.60	0.91	1.33	0.64	1.00	0.63	2.59	
p = 0.01		1.22	3.03	2.16	1.24	1.79	0.86	1.36	0.85	3.50	
p = 0.001		1.62	4.03	2.88	1.64	2.38	1.14	1.80	1.13	4.65	

At an earlier stage of this trial May appeared to be the best month for spraying, but following the crops of 1960 and particularly 1961 there is now little to choose between the times of spraying, which have all raised the mean annual yields by between 1 and 1¾ cwt. of clean coffee per acre. August was the least satisfactory time for the spray treatments which were most successful when applied in mid-May or mid-June. There was no significant difference between the volume and rates of treatments therefore the most economical was 3.4 lb. of a 50% copper fungicide in 100 gallons of water and sprayed at the rate of 1 pint per tree.

TABLE XXX

1961 yields

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Spray volume treatments	*Copper Spray Timing*			*Means for Volume*
	No spray	*May*	*September*	
Control	5.57	—	—	5.57
Low volume approx. ½ pt./tree	—	6.45	5.06	5.75
High volume approx. 1½ pt./tree	—	5.63	6.22	5.92
Means for spray timing	5.57	6.04	5.64	5 75
Coefficient of variation				16.71
		No significant difference		

Coffee Research Substation, Kisii

Spray timing and volume are studied in a trial of a 3 × 2 factorial design which was begun in 1959 on mature shaded multiple-stem coffee. The low volume treatment is applied with a motorised knapsack "mist blower" ('Motoblo') and the high volume treatment is carried out with a hand-operated hydraulic knapsack sprayer ('Saval'). Other details and the first yield records are given in Table XXX.

The 1961 results revealed no significant difference between treatments, although these had been applied in 1960 and 1961.

Coffee Research Substation, Upper Kiambu

The treatments of this experiment are in addition to the overall spraying of the coffee with high volume of copper fungicide sprays for the control of Coffee Berry Disease, and which are applied in February, March and April.

Eight treatments are grouped in randomised blocks and replicated four times. Each plot consists of ten trees spaced at 10 ft. × 10 ft. on the triangle and the whole area is under the shade of *Grevillea robusta* trees. The treatments shown in Table XXXI were first applied in 1959, but as the trees were in the process of being converted from single- to multiple-stem the first substantial crop was recorded in 1961.

TABLE XXXI
1961 Yields
(cwt. clean coffee per acre)

Sprays applied in mid-May	*Volume pint/ tree*	*50% Copper fungicide*		*Yield*
		Concentration % w/w	*lb. per acre*	
Control		—	—	9.96
Hand Operated sprayer	1	0.68	4.28	12.92
	1	1.36	8 55	11.50
Motorised Knapsack "Mist blower"	1	0.68	4 28	13.03
	¼	0.68	1.07	12.06
	¼	1.36	2.14	11.15
	¼	2.04	3.21	14.76
	¼	2.72	4.28	13.45
Mean				12.35
Coefficient of variation %				21.26
Least significant difference p = 0.05				3.86

In 1961 there was a clear indication that all spray treatments had tended to raise the yield of coffee, but as the variability was somewhat high only one treatment could be shown to be significantly different from the 'control'. This was the low-volume application of ¼ pint per tree of the high fungicide concentration containing 2.04 lb. of the 50% formulation per 10 gallons of spray. This was equivalent to the application of 3.21 lb. of fungicide per acre.

North Kitito Estate, Makuyu

The trial was begun in 1954 to determine the correct time at which to apply a copper fungicide to reduce the premature loss of leaves. In all cases the concentration of chemical was 6.8 lb. of a 50% copper fungicide per 100 gallons of water and approximately 1 pint was applied to each tree. The exact volume was varied according to the average size of the trees each year. The three times studied were—early in the Long Rains (usually the first week in April), late in the Long Rains (usually the last week in May) and early in the Short Rains, which was generally the first week in November. The first crop was recorded in 1955 when the coffee sprayed late in the Long Rains yielded 3¼ cwt. clean coffee more than the unsprayed trees. As the trial continued, the early Long Rains treatment became progressively superior to the two other spray timings. This was particularly noticeable in the 1959 yields. It appeared that the spray in April 1958 had had a marked effect in reducing the attack of Leaf Rust which developed later that year.

TABLE XXXII

Annual Yields 1955-1961

(cwt. clean coffee per acre)

Copper Spray Timing	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1955–1961*
No Spray	4.56	6.25	5.39	10.36	5.66	4.79	3.89	5.84
April	6.93	7.10	8.64	10.33	14.08	3.31	6.94	8.19
May/June	7.83	6.99	7.90	12.11	7.11	5.38	7.06	7.77
November	5.43	6.86	8.44	9.50	7.92	4.14	4.78	6.72
Mean	6.19	6.80	7.59	10.58	8.69	4.40	5.67	7.13
Coefficient of variation %	24.70	14.17	14.86	14.11	14 86	17.90	19.80	6.88
Least significant difference p = 0.05	2.45	1.54	1.80	2.39	2.07	1.26	1.80	0.78
p = 0 01	3.52	2.21	2.59	3.43	2.97	1.81	2.58	1.13
p = 0.001	5.18	3.26	3.81	5.05	4.36	2.66	3.79	1.66

These results indicate quite clearly that all spray treatments have raised yields considerably, that the Long Rains is the more important time to spray, but that over seven seasons there is little difference between applying the fungicide early or late in the Rains. The early Long Rains spray treatment raised the mean annual yield by 2.35 cwt. of clean coffee per acre. There is no other coffee cultural practice known which will produce a 40% yield increase for so small an expense as is represented by one fungicide spray a year.

Meru District

In 1959 three exploratory trials were sited in contrasting ecological zones on the slopes of Mount Kenya. Each trial consists of three or four randomised blocks of the three treatments shown in Table XXXIII. The individual plot sizes are seven trees at Katheri, eight trees at Kinjo and nine trees at Ruiga. The first sprays were applied in December 1959 and at all times 1 pint was used per tree and the spray fluid was made up to contain 6.8 lb. of a 50% copper fungicide per 100 gallons.

TABLE XXXIII

Annual Yields 1960-1961

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

Coffee Zone / *Spray timing*	*Low Ruiga*			*Medium Kinjo*			*High Katheri*			*Means for all sites*		
	1960	*1961*	*1960-1961*	*1960*	*1961*	*1960-1961*	*1960*	*1961*	*1960-1961*	*1960*	*1961*	*1960-1961*
No spraying	17.99	1.34	9.67	12.72	14 32	13.52	12 91	11.91	12.41	14 54	9.19	11.87
December	18 88	1.35	10.12	14.43	15.76	15.10	9.93	9.48	9.71	14 41	8.86	11 64
May	19.09	2.70	10.90	13.27	15.68	14.48	14.06	12.96	13.51	15.47	10.45	12.96
Mean	18.66	1.80	10.23	13.47	15.25	14.36	12.30	11.45	11.88	14.81	9.50	12.16
Coefficient of variation %	17.27	36.83		27.74	26.80		15.27	17.20				
Least significant difference p=0.05	7.30	1.50		6.47	7.07		3.25	3.41				

Results obtained during 1960 and 1961 are quite inconclusive and give little indication of the substantial increases in yield which have been recorded in other trials of this type.

At Kinjo and Ruiga there are indications that the coffee does respond to the copper spray treatments but the high coefficients of variation indicate the lack of precision of these results. At Katheri it appears that the December spray has depressed the yield of coffee, but this observation will require further confirmation before being accepted.

PRUNING TRIALS

Coffee Research Station: Trial I

There are six randomised blocks of the four treatments shown in Table XXXIV and each plot consists of 16 trees spaced at 10 ft. × 10 ft. This trial has now been recorded for 16 years and is the longest established on the Coffee Research Station. From 1951 each picking has been sampled to provide an accurate estimate of the ratio of cherry weight to clean coffee production and from these samples the yield of Grade 'A' coffee has been determined

TABLE XXXIV
Mean annual yields 1946-1961
(cwt. clean coffee per acre)

Pruning System	*1946-1961 Gross Yield*	*1951-1961*	
		Grade 'A' Yield	*% of Total*
Multiple stem 3 heads	7.89	3.27	35.53
Single stem capped once	7.94	3.36	33 09
Single stem capped thrice	7.46	3.15	32.59
Single stem two stems.	7.94	3.32	33.34
	No significant difference		
Mean	7.81	3.28	—
Coefficient of variation %	7.57	10.59	—

It is clear from the mean annual yields that there is no significant difference in the production from single- and multiple-stem coffee where both methods of pruning have been carefully regulated. Yields from individual years have shown great differences between treatments but in the long run such contrasts have evened out and are evident neither in the gross yield nor in the production of Grade 'A' coffee. There is a slight trend in favour of multiple-stem coffee when the Grade 'A' yield is expressed as a percentage of the gross production.

Coffee Research Station: Trial II

An experiment was begun in 1957 to study in detail the pruning of multiple-stem coffee. The trial was sited on coffee planted in 1956, from which three crops have now been harvested. The main treatments and the mean annual yields for 1959–1961 are summarised in Table XXXV.

It is interesting that the wide range of the lengths of head from about 3 feet to 4½ feet had little effect on the level of cropping. Where no secondaries were permitted the yield was significantly less than from trees with up to four bearing secondaries on a primary branch. From a consideration of the results so far, it appears that approximately 4 feet of bearing wood can be left on each head and that at pruning up to four secondaries can be permitted on any one primary. During the remainder of the year secondaries should not be removed except to keep the centre of the tree open. This may be achieved by removing secondary growth arising within 1 to 1½ feet of the main stems.

TABLE XXXV
Mean annual yields 1959-1961
(cwt. of clean coffee per acre)

Multiple Stem Pruning 2 heads per tree	*Pruning of primaries*				
Pruning of Secondaries	*Cut up to 2 nodes above "break"*	*Cut up to "break"*	*Cut up to 2 nodes below "break"*	*Cut up to 4 nodes below "break"*	*Means*
Only secondaries on inmost 18″ removed	10.24	8.43	8.79	10.68	9.54
Maximum of 4 secondaries bearing per primary	9.95	9.33	10.79	10.89	10.24
All secondaries removed at pruning	9.32	8.03	9.51	10.83	9.42
Secondaries removed throughout the year	8.37	9.93	7.83	8.75	8.72
Means	9.47	8.93	9.23	10.29	9.48

TABLE XXXV (*Continued*)

Single Stem Pruning per tree	*Primary Regulation* 20 Primaries	25 Primaries	30 Primaries	Approx. 35 Primaries	*Means*
Secondary Regulation					
4 ft. bearing/primary	4.77	5.39	6.15	6.90	5.80
3 ft. bearing/primary	5.79	6.58	6.14	5.57	6.02
2 ft. bearing/primary	4.54	5.03	5.85	5.80	5.31
1 ft. bearing/primary	2.84	3.41	3.34	5.19	3.70
Means	4.49	5.10	5.37	5.87	5.21
Least significant difference	*Within the tables*		*Between marginal means*		
p = 0 05	1.69		0.85		
p = 0.01	2.33		1.16		
p = 0.001	3.18		1.59		

As a subsidiary treatment throughout the trial half the coffee was brought up as single-stem, but with the intention that once the trees were fully established they would be converted to the full range of multiple-stem pruning treatments. This conversion was initiated after the 1961 crop had been harvested by removing all primaries on one side of each single-stem tree.

Between 1957 and 1961 the crop was regulated on the single-stem trees according to treatments arising from the factorial combination of four degrees of primary reduction and four methods of secondary control. On single-stem trees the crop is carried on wood arising from the primary branches which themselves should bear little or no coffee. In the lower half of Table XXXV the combinations of treatments can be expressed as yield per length of bearing surface by multiplying the number of primaries by the length of bearing wood per primary. The range of yields recorded was narrower than had been hoped but fairly consistent with the estimated bearing surface. It is evident that with a

TABLE XXXVI

Mean annual yields 1960-1961

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

Pruning Method	*1961* Time of Pruning		*Means for method of pruning*	
	After Stripping	*After Flowering*	*1961*	*1960-1961*
Single stem 20 primaries	1.78	1.28	1.53	3.99
Single stem 25 primaries	3.56	2.49	3.02	4.12
Single stem 35 primaries	4.12	2.52	3.32	4.77
Mean for single stem			2.62	4.29
Multiple stem 2 × 4 ft. heads	2.91	2.62	2.76	6.28
Multiple stem 2 × 4½ ft. heads	3.18	2.81	2.99	6.32
Mean for multiple stem			2.88	6.30
Mean for time of pruning	3.11	2.34	2.73	5.10
Coefficient of variation %			36.10	
Least significant difference	*Between pruning times*	*Within the Table*	*Between single and multi-stem*	
p = 0 05	0.75	1.69	0.77	
p = 0.01	1.03	2.31	1.05	

small number of primaries secondary regulation has had greater influence than where primaries were unlimited and there were about 35 per tree.

From a general consideration of the results and field observations the most satisfactory treatment was to restrict the number of primaries per tree to 25, and on each to allow 3 feet of wood to bear each year.

Coffee Research Substation, Kitale

Coffee planted in 1957 was used for this trial which was laid down in 1959 to compare single- and multiple-stem pruning systems and to investigate the time at which coffee should be pruned. There are three replications of a 5 × 2 factorial design with 16-tree plots of coffee spaced at 9 ft. × 9 ft. under shade.

In 1961 the level of cropping was low following the unduly heavy first yields of 1960. The importance of early pruning is clear, particularly where there is the potential for a good crop. The mean yields for 1960 and 1961 show that the multiple-stem treatments have yielded more than the single-stem, but that within either system there is little difference.

Coffee Research Substation, Upper Kiambu

This trial was planned and laid out in 1959, but the first differential treatments were carried out early in 1961 when the conversion from the single- to multiple-stem growth had been completed. There are four replications of a 2 × 3 factorial design to compare two times of pruning and three severities of multiple-stem crop regulation. In 1961 the "light pruning" involved no reduction of primaries, while "medium pruning" consisted of removing primaries from the lowest 6 inches of the bearing stems and "severe pruning" implied cutting off primaries from the lowest 1 foot of each head. The mean lengths of bearing heads were then 5 feet, 4½ feet and 4 feet. The early pruning was done on 17th February and the second treatment on 27th March.

TABLE XXXVII

Annual yields 1960-1961

(cwt. clean coffee per acre)

Time of pruning	*Method*	*1960*	*1961*	% *Grade 'A'*
After stripping				
	Light	2.21	7.71	39.01
	Moderate	1.88	7.10	39.86
	Severe	2.65	5.77	40.67
Mean		2.25	6.86	39.80
After main flowering				
	Light	2.50	8.63	46.91
	Moderate	1.62	6.31	44.67
	Severe	2.53	6.43	52.98
Mean		2.22	7.12	48.17
General Mean		2.23	6.99	44.06
Coefficient of variation %		30.38	37.24	
Least significant difference				
between times of pruning	p = 0 05		2.26	
between methods of pruning	p = 0.05		3.92	

The variability of the coffee does not allow any precise conclusions from these early results, but certain trends are already evident. The delayed pruning resulted in a distinctly higher Grade 'A' percentage particularly where the heads were restricted to about 4 feet, however none of these differences is statistically significant.

Coffee Research Station

From this trial and others of similar design on substations it is hoped to obtain a better understanding of the integration and interactions of several well-established cultural practices. Eventually it should be possible to advise growers on the most economical combinations of good farming methods.

The formal design of this experiment is 2^5 factorial with two absolute replications, but from its inception in 1957 only four factors and their interactions have been tested and the results are given in Table XXXVIII. Irrigation is to be included as the fifth factor from the middle of 1962.

TABLE XXXVIII

Annual yields 1959-1961

(cwt. clean coffee per acre)

Main Treatments	*1959*	*1960*	*1961*	*1959-1961*
+a Alternate inter-rows mulched	8.50	5.53	8.19	7.40
−a No mulch . . .	7.02	2.63	6.73	5.46
Effect of A	+1.48	+2.90	+1.46	+1.94
+b Clean weeding at all times .	7.89	4.28	8.03	6.73
−b Weeds slashed in Rains .	7.63	3.88	6.89	6.13
Effect of B	+0.26	+0.40	+1.14	+0.60
+c Copper spray in May .	7.86	4.14	7.72	6.57
−c No May spray . . .	7.66	4.02	7.20	6.29
Effect of C	+0.20	+0.12	+0.52	+0.28
+d Nitrogen fertilizer 46 lb. N/acre . . .	7.76	3.97	7.60	6.44
−d No fertilizer . . .	7.76	4.19	7.32	6.42
Effect of D	±0.00	−0.22	+0.28	+0.02
General mean	7.76	4.08	7.46	6.43
Least significant difference				
p = 0 05 . . .	1.26	0.86	1.18	1.02
p = 0 01 . . .	1.69	1.15	1.59	1.37
p = 0.001 . . .	2.24	1.53	2.11	1.82

The only treatment which raised the yield between 1957 and 1961 was alternate inter-row mulching The failure of the other main treatments to influence the cropping is remarkable. However it appears that gradually the benefit of clean weeding will attain statistical significance. There were no interactions of interest to report, and this trial will have to continue for many more years to achieve its object, although it has already high-lighted the very great importance of mulching in the management of young coffee.

Saboti Estate, Mount Elgon: Trial I

In 1958 this trial was started at the insistence of local farmers to investigate various cultural practices which might induce more regular flowering and reduce the biennial fluctuations in yield which were most marked on Mount Elgon.

The three factors shown in Table XXXIX are combined in a 2^3 factorial design with four replications. There are 25 coffee trees and two *Grevillea robusta* trees per plot; the coffee being spaced at 10 ft. × 8 ft. and the shade trees at 40 ft. × 40 ft.

The dry weather deep cultivation was suggested by a local coffee grower who considered that a moderate "root pruning" would tend to restrict vegetative growth and encourage more profuse flowering at the onset of the wet weather.

TABLE XXXIX

Annual yields 1959-1961

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

	1959	*1960*	*1961*	*1959-1961*
Pruning Time				
After stripping	4.19	11.76	4.29	6.74
After main flowering	3.08	13.04	2.84	6.32
Cultivation in dry season				
None	4.01	12.02	3.22	6.41
1 deep cultivation	3.26	12.78	3.91	6.65
Copper Spraying 1 to 2 pints/tree				
None	3.66	10.77	2.05	5.49
May and September 6.8 lb. 50% copper fungicide/100 galls.	3.61	14.03	5.08	7.57
Mean	3.63	12.40	3.56	6.53
Coefficient of variation %	28.91	20.08	63.36	
Least significant difference				
p = 0 05	0.77	1.83	1.66	
p = 0.01	1.05	2.49	2.26	

TABLE XL

1961 Yields

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

Treatments	*S_0 None*	*S_1 March*	*S_2 May*	*Copper Spraying*	*N_0 0*	*N_1 46*	*N_2 23+23*	*Nitrogen fertilizer/acre*	*Means for mulch treatments*
Mulch and Green manure									
M_0 None	5.98	8.35	8.44		8.55	6.18	8.04		7.59
M_1 6ft. strip in row mulch at the end of the Rains	4.63	9.06	9.56		7.66	8.89	6.70		7.75
M_2 6 ft. strip inter-row lupins	7.28	8.28	10.25		7.07	6.80	11.94		8.60
Nitrogen fertilizer									
N_0 None	4.82	8.81	9.65		7.76				
N_1 46 lb. nitrogen/acre (April) applied after main flowering	6.50	7.15	8.22			7.29			
N_2 23 lb. nitrogen/acre (April) applied after main flowering 23 lb. nitrogen/acre (August) during crop maturation	6.57	9.73	10.38				8.89		
Means for copper spraying	5.96	8.56	9.42						7.98
Coefficient of variation %									13.76
Least significant difference	*Within the Tables*				*Between marginal means*				
p = 0 05	1.91				1.10				
p = 0 01	2.64				1.53				
p = 0.001	3.65				2.11				

The yields for the first three crops from this experiment clearly show that the copper spraying in May and September raised the yield of coffee and also moderated the biennial bearing characteristic.

Early pruning did not affect the mean annual yields, but from the results so far available it seems slightly to reduce the amplitude of the biennial swing in cropping level.

Saboti Estate, Mount Elgon: Trial II

The young coffee on which this trial was laid down in 1959 cropped for the first time in 1961, and produced some extremely interesting results. The three main treatments are factorially combined in a 3^3 design with one absolute replication arranged in three blocks of nine plots each. Individual plots contain 16 coffee trees at 10 ft. × 7 ft. and one *Cordia abyssinica* tree at 42 ft. × 40 ft. for permanent shade.

The copper spraying has been the most effective single treatment and its application in May rather more productive than March. The mulch treatment failed to raise the yield, but the 6-foot strip of lupins raised the yield of coffee to an extent just statistically significant at $p=0.05$. This was also the result from the split application of nitrogen fertilizer, but there was no overall response to 46 lb. nitrogen applied in April. Several interactions of importance are shown in Table XL, however the most productive combination was 177 lb. ammonium sulphate nitrate equally split between April and August, with lupins grown in the inter-row space during the Rains and the coffee sprayed with a copper fungicide in May.

Coffee Research Substation, Upper Kiambu

The first treatments of this trial were applied during 1959, but as the coffee was in the process of being converted from single- to multiple-stem the first crop of any interest was recorded in 1961. Five factors are combined in a 2^5 design with two replications each made up of four blocks of eight plots. There are ten trees per plot spaced at 10 ft. × 10 ft. on the triangle and the whole trial is under *Grevillea robusta* shade. Three of the factors and the 1961 yields are shown in Table XLI. The fourth treatment tests ammonium sulphate nitrate at 177 lb. per acre applied in the Long Rains and the final comparison will be between single- and multiple-stem pruning.

TABLE XLI

1961 Yields

(cwt. clean coffee per acre)

Weeding Policy in Rains	*May Copper Spray*		*Alternate inter-row mulching*		*Weeds during Rains Means*
	Without	*With*	*Without*	*With*	
Tall weeds	8.17	9.54	8.26	9.44	8.85
Clean weeding	9.14	10.90	10.62	9.42	10.02
Means	8.66	10.22	9.44	9.43	9.44
Coefficient of variation %					15.47
Least significant difference		*Within the Tables*			*Between means*
$p = 0.05$		1.06			0.75
$p = 0.01$		1.43			1.01
$p = 0.001$		1.90			1.34

The spray treatment is applied in addition to routine high-volume copper sprays which are put on the coffee in February, March and April to control Coffee Berry Disease, and yet in 1961 this May treatment raised the yield by 1.56 cwt. of clean coffee per acre. Thorough weed control during the Rains also raised the yield by more than 1 cwt. per acre, but there was no overall response to mulching. In fact mulch depressed the yield of clean weeded coffee, though where no weeding was done during the rains mulching raised the yield of coffee. A response to nitrogen fertilizer was restricted to coffee which suffered weed competition during the Rains, but did receive a copper spray in May.

SHADE TRIAL

Saboti Estate, Mount Elgon

The coffee of this trial was planted in 1958 at a spacing of 10 ft. × 7 ft. on the contour and the shade trees were planted when the trial was designed a year later. Each plot includes 36 coffee trees and three shade trees which are spaced at 40 ft. × 42 ft. The plots are so arranged as to minimise the shading of one plot by trees of the adjacent plot. There are four replications of the four shade treatments which are arranged in randomised blocks.

TABLE XLII

1961 Yields

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

Shade Trees spaced at 42 × 40 ft.	*1961*
No shade	6.33
Cordia abyssinica	5.49
Schizolobium excelsum and *C. abyssinica*	4.96
Grevillea robusta	4.82
	No significant difference
Mean	5.40
Coefficient of variation %	25.64

The first crop was recorded in 1961, but there was no significant difference between treatments. The shade trees were still very young and cannot be expected to have much influence on the yield of coffee for several years.

ROBUSTA COFFEE SPACING TRIAL

Busia, Elgon Nyanza

The main treatments of this trial are shown with the first yields in Table XLIII, but the layout of the experiment provides for subdivision of the main plots to allow the comparison of six and eight heads per tree during the second pruning cycle. The trial was planted in 1958 with five replications of the four spacing treatments and there are 20 trees recorded individually in each main plot. The first picking was in August 1960 and small amounts of cherry were weighed at various times until July 1961.

TABLE XLIII

1960/61 Yields of Cherry

Spacing in ft.	*Trees per acre*	*% Trees bearing*	*Yield of bearing trees cwt./acre*	*Yield per bearing tree lb./tree*
9 × 9	537	58.5	23.82	4.36
10 × 10	435	63.0	18.68	4.81
11 × 11	360	64.0	15.16	4.72
12 × 12	302	74.5	14.84	4.98
Mean			18.13	4.72
Coefficient of variation %			23.71	
Least significant difference				
p = 0 05			4.17	
p = 0.01			5.87	
p = 0.001			8.30	

There appears to have been a better initial establishment at the wider spacings, however if only the bearing trees are considered the mean yield per tree has been 4.72 lb. of cherry and as there is no effect of spacing on the yield per bearing tree it may be seen that the 9 ft. × 9 ft. spacing is the most productive at this stage.

VARIETY TRIALS

Central Province

COFFEE RESEARCH STATION, TRIALS I AND II. 5,300 feet.

These trials were planted in 1950 and 1951 respectively and at least ten crops will be recorded from each before it is concluded. Both trials are of an incomplete block design but only Trial I is balanced. There are 20 trees per plot spaced at 9 ft. × 9 ft. and pruned on a multiple-stem system.

TABLE XLIV

Mean annual yields 1953-1961

(cwt. clean coffee per acre)

	TRIAL I		*TRIAL II*	
	Variety	*1953-1961*	*Variety*	*1954-1961*
1	SL 28	11.20	SL 34	11.08
2	SL 19	11.16	N 218	10.25
3	SL 14	10.70	Dalle mixed	9.66
4	SL 30	10.27	SL 9	9.51
5	SL 17	10.27	M 6	9.35
6	SL 1	9.43	Kenya Selected	9.34
7	KIT 107	9.11	K 7	9.26
8	KIT 27	9.10	Series "L"	9.26
9	KIT 37	9.05	M 83	9.19
10	KIT 251	8.85	SL 28	9.10
11	KIT 13	8.79	SL 18	8.72
12	KIT 64	8.46	Mocha	8.63
13	KIT 85	8.44	N 100	8.63
14	KIT 106	8.35	M 65	8.57
15	KIT 145	8.34	Kents	8.44
16	KIT 109	8.06	KP 532	8.12
17			SL 2	8.01
18			SL 10	7.89
19			M 48	7.65
20			Dilla & Alghe	7.24
21			SL 6	7.11
	Mean	9.35		8.81
	Coefficient of variation %	7.08		8.64
	Least significant difference			
	p = 0 05	0.94		1.05
	p = 0.01	1.26		1.40
	p = 0.001	1.63		1.82

The nine-year mean annual yields provide a clear distinction between the Scott Laboratory selection (SL) and those made on Kitamaiyu Estate (KIT). With the exception of SL 1, all SL selections have outyielded all KIT numbers but, again with the exception of SL 1, within each group there is no difference of importance. The present policy of distributing seed of SL 28 is well justified, but SL 14, 17, and 19 should not be discarded. SL 30 is very susceptible to Leaf Rust and therefore is not suitable for general distribution.

Trial II includes a wider range of selections than Trial I and once again a SL selection heads the eight-year mean annual yields although SL 34 has not significantly outyielded the Tanganyika

selection N 218. Most of the selections known to be resistant to Race II of Leaf Rust appear low in Table XLIV (Kents, KP 532, Dilla and Alghe and SL 6) but only SL 34 has yielded significantly more than K 7.

The high placing of SL 30 in Trial I and the poor performance of most of the Rust resistant selections in Trial II raises the question of how economically important is the control of Leaf Rust at the Coffee Research Station.

KENTMERE ESTATE, UPPER KIAMBU, TRIALS I AND II. 6,300 feet.

Both trials were planted in 1954 according to balanced lattice designs with 15-tree plots. The main purpose of the trials was to assess the performance of selections under conditions of high altitude and potentially severe attacks by Coffee Berry Disease (*Colletotrichum coffeanum*) therefore no attempt was made to control the disease by fungicide spraying until 1961. Then the second trial was divided so that two replicates received the recommended copper spray treatments, while two replicates and the whole of Trial I remained unprotected against this disease.

TABLE XLV

Annual yields 1958-1961

(cwt. clean coffee per acre)

TRIAL I

Variety		*1958*	*1959*	*1960*	*1961*	*1958-1961*	*% Grade 'A'*
Blue Mountain	P 13	4.95	4.08	7.51	5.94	5.62	34.70
Blue Mountain	K 7	4.78	3.71	7.25	6.48	5.56	39.75
Blue Mountain	I 11	4.35	3.65	7.78	6.39	5.54	31.95
Blue Mountain	Q 6	3.85	3.93	7.20	6.87	5.46	31.50
Blue Mountain	N 1	3.58	3.50	7.62	6.54	5.31	34.27
Blue Mountain	L 3	3.91	3.80	7.45	5.10	5.07	27.22
Blue Mountain	J 7	3.37	3.77	6.56	5.60	4.83	26.09
Blue Mountain	R 12	4.49	2.75	7.16	4.77	4.79	24.01
Blue Mountain	P 12	3.81	3.82	7.02	4.43	4.77	20.75
Blue Mountain	S 10	3.47	2.92	7.29	5.06	4.69	26.01
Blue Mountain	W 12	2.98	3.34	7.09	5.03	4.61	31.45
Kenya Selected		3.20	3.40	5.15	6.58	4.58	40.82
Blue Mountain	P 8	3.85	2.74	7.21	4.33	4.53	30.24
Blue Mountain	S 5	3.21	2.80	6.84	4.84	4.42	24.89
Blue Mountain	V 13	2.94	3.65	6.05	4.13	4.19	27.21
Geisha	10	2.90	3.88	1.14	3.64	2.89	24.56
Mean		3.73	3.48	6.65	5.36	4.80	
Coefficient of variation %		18.93	21.05	18.06	11.72	8.83	
Least significant difference							
p = 0.05		0.90	0.94	1.54	0.80	0.54	
p = 0.01		1.21	1.25	2.05	1.07	0.72	
p = 0.001		1.59	1.65	2.70	1.41	0.95	

Trial I was slow to come into full production but over the first four years it can be seen that the mean annual yield for the best Blue Mountain selection in Trial I was almost identical with that of Blue Mountain N 4 in the second Trial. The differences between the Blue Mountain selections were slight but there were considerable differences between the percentages of Grade 'A' coffee picked from the selections. The bean size was generally small but Blue Mountain K 7 was clearly the most satisfactory selection.

Trial II showed that SL 34 and SL 28 were the most productive selections even without spraying and furthermore yielded a far higher proportion of Grade 'A' coffee. The copper sprays applied to half the trial in 1961 did not lead to clear responses for although the selections known to be very susceptible to Coffee Berry Disease all yielded more after spraying, the Blue Mountain selections reacted erratically.

TRIAL II

Variety	1958	1959	1960	1961	1958–1961	% Grade 'A'	1961 Yield Response Sprayed
	Unsprayed for Coffee Berry Disease Control						
SL 34	7.73	8.72	5.36	5.33	6.79	49.48	5.92 + 0.59
SL 28	7.73	7.98	5.51	5.39	6.65	52.63	6.48 + 1.09
Ke 20	6.56	2.84	10.99	3.36	5.94	31.82	2.83 — 0.53
Kents	7.51	4.88	6.04	4.79	5.81	31.67	5.34 + 0.55
Blue Mountain N 4	6.71	2.80	9.90	3.09	5.63	26.11	3.05 — 0.04
Blue Mountain I 5	6.79	2.67	10.11	2.74	5.58	22.94	2.60 — 0.14
Geisha 1	6.42	6.68	2.30	5.72	5.28	10.42	5.47 — 0.25
Blue Mountain X 6	5.83	2.93	8.65	3.20	5.15	27.57	4.18 + 0.98
Blue Mountain U 4	6.59	1.59	8.33	0.91	4.36	32.34	2.73 + 1.82
Mean	6.87	4.57	7.47	3.84	5.69		4.29
Coefficient of variation %	11.46	17.05	16.49	19.89	8.01		16.29
Least significant difference							
p = 0.05	1.18	1.17	1.85	1.76			1.61
p = 0.01	1.63	1.61	2.54	2.56			2.34
p = 0.001	2.24	2.21	3.50	3.85			3.52

NORTH KITITO ESTATE, MAKUYU. 4,900 feet.

The trial was planted in 1953 and included six varieties which were replicated five times in 20-tree plots. The first crop was permitted in 1956 when the mean yield for the trial was ¾ ton of clean coffee per acre, with the heaviest crop from SL 28 (17.94 cwt.). This variety maintained its leading position in all years except 1959 and even in that season was not significantly inferior in yield to any of the other varieties. Six crops have now been recorded from this trial, which was concluded in 1961.

TABLE XLVI

Annual yields 1956–1961

(cwt. clean coffee per acre)

Variety	1956	1957	1958	1959	1960	1961	1956/1961
SL 28	17.94	13.12	10.52	6.90	9.26	12.91	11.78
Meru Kents	15.07	10.62	8.27	8.36	6.55	11.38	10.04
SL 14	14.43	9.77	9.77	5.98	5.74	12.64	9.72
SL 9	13.18	10.31	9.58	5.87	6.49	11.16	9.43
K 7	14.43	9.55	6.04	8.56	4.65	11.98	9.20
Kenya Selected Series 'A'	14.08	9.51	6.63	4.40	6.36	9.80	8.46
Mean	14.86	10.48	8.47	6.68	6.50	11.65	9.77
Coefficient of variation %	24.72	9.55	10.77	22.33	16.66	7.45	8.68
Least significant difference							
p = 0.05	4.85	1.32	1.20	1.97	1.43	1.14	1.12
p = 0.01	6.61	1.80	1.64	2.68	1.95	1.56	1.53
p = 0.001	8.94	2.44	2.22	3.63	2.64	2.11	2.07

SL 28 out-cropped all other selections while Kenya Selected Series 'A' yielded significantly less than SL 28, Meru Kents and SL 14. At planting time treatments were superimposed to ascertain the effect of nitrogen, phosphate, potash and cattle manure upon establishment and early growth. The N.P.K. addition led to death of plants at 1–3 months after initial establishment, probably due to very dry conditions and the effect of potash in the planting holes. Cattle manure was very clearly beneficial in its effect upon early growth of seedlings.

SCOTT AGRICULTURAL LABORATORIES, KABETE. 5,700 feet.

Nine selections are grouped in randomised blocks and replicated six times. There are 15 trees in each plot and the coffee was planted at a spacing of 9 ft. × 9 ft. in 1956.

TABLE XLVII

Annual yields 1959-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	*1959*	*1960*	*1961*	*1959-1961*
SL 18	5.30	7.85	4.93	6.02
SL 28	7.26	5.11	5.15	5.89
SL 17	5.34	6.61	4.35	5.43
Kenya Selected Series 'A'	4.96	6.90	2.95	4.93
SL 34	5.28	4.84	3.95	4.69
Ke 20	3.78	6.58	3.02	4.46
SL 6	3.50	4.60	3.15	3.75
K 7	3.21	4.47	3.00	3.56
Blue Mountain	2.81	4.51	1.91	3.07
Mean	4.60	5.72	3.60	4.64
Coefficient of variation %	22.08	21.12	36.55	17.40
Least significant difference				
p=0.05	1.68	1.41	1.54	0.94
p=0.01	2.25	1.88	2.05	1.26
p=0.001	2.95	2.48	2.70	1.65

The level of cropping of this trial has been very disappointing and shows no sign of improvement with time. SL 17, SL 18, and SL 28 have yielded the most coffee, and of these SL 28 has shown the least fluctuation in yields from year to year. SL 34 has not shown up well in this trial and the performance of Blue Mountain has been particularly poor.

COFFEE RESEARCH SUBSTATION, MARIENE, MERU. 5,300 feet.

A small crop was picked in 1961 from this trial which was planted in 1959. The 16 varieties are laid out in a balanced lattice design with ten-tree plots.

TABLE XLVIII

1961 Yields

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

Variety	*Yield*
N 39	5.14
N 218	4.34
SL 6	3.80
S 795	3.38
KP 532	3.17
Dalle Melville	3.05
Meru Kents	2.74
SL 28	2.69
K 7	2.67
S 288	2.35
BA 35	2.02
S 333	2.01
BA 10	1.79
SL 14	1.46
SL 34	1.30
BA 16	0.65
Mean	2.66
Coefficient of variation %	44.71
Least significant difference	
p = 0.05	1.52
p = 0.01	2.03
p = 0.001	2.67

A wide range of yields was recorded in 1961 and showed that the selections from Tanganyika (N 39, N 218 and KP 532) and those derived from Kents (SL 6, KP 532 and Meru Kents) have tended to come into bearing more rapidly than the other Kenya and Indian varieties. N 39 is noted for the quality of its liquor so it is to be hoped that the early cropping characteristic will not impair its later performance.

MERIGA MIERU, MERU. 5,500 feet.

This 5 × 5 Latin Square of nine-tree plots was planted in 1951 and the eight crops recorded have shown clearly that SL 28 and SL 34 have outyielded all other varieties.

TABLE XLIX
Annual yields 1954–1961
(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1954–1961*
SL 28	24.15	9.50	23.54	8.33	16.87	18.29	21.90	11.05	16.70
SL 34	19.28	9.41	26.29	9.88	17.12	17.48	17.78	8.97	15.78
Kenya selected	21.16	5.70	21.16	8.81	9.93	12.79	15.98	10.16	13.21
Meru Kents	11.36	6.23	18.05	6.23	7.64	10.19	17.33	7.24	10.53
N 100	14.04	9.25	19.44	5.70	8.90	8.42	12.57	2.36	10.09
Mean	18.00	8.02	21.70	7.79	12.09	13.43	17.11	7.96	13.26
Coefficient of variation %	32.00	32.00	32.00	30.46	30.89	32.01	26.28	38.64	11.76
Least significant difference									
p = 0.05	7.91	3.52	9.53	3.26	5.13	5.90	6.17	4.22	2.14
p = 0.01	11.13	4.96	13.42	4.59	7.22	8.31	8.69	5.95	3.02
p = 0.001	15.74	7.01	18.97	6.48	10.20	11.75	12.29	8.40	4.26

There was no significant difference between the yields of SL 28 and SL 34, Kenya Selected occupied an intermediate position and Meru Kents and N 100 yielded significantly less than the other selections.

KIRIANI, CHOGORIA, MERU. 5,100 feet.

This trial was planted in 1951 at the same time as the one at Meriga Mieru and is of the same size and design.

TABLE L
Annual yields 1954-1961
(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6: 1)

Variety	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1954-1961*
SL 18	19.94	5.91	28.71	3.50	13.29	4.82	8.55	5.92	11.33
SL 28	18.87	5.43	25.07	1.88	12.10	7.20	8.33	7.13	10.75
SL 9	10.44	5.24	28.40	2.38	14.82	6.99	6.43	8.66	10.42
Meru Kents	8.87	5.16	26.20	11.73	8.06	5.49	8.58	5.59	9.96
Mocha	14.01	2.91	18.39	0.69	5.47	5.93	5.95	5.11	7.31
Mean	14.43	4.93	25.35	4.04	10.75	6.09	7.57	6.48	9.95
Coefficient of variation %	—	30.60	14.33	8.20	34.91	8.59	25.47	20.43	8.54
Least significant difference									
p=0 05		2.07	4.99	0.45	5.15	0.72	2.65	1.82	1.17
p=0 01		2.91	7.02	0.64	7.25	1.01	3.73	2.56	1.64
p=0.001		4.12	9.92	0.90	10.25	1.43	5.27	3.62	2.32

The differences between the mean annual yields are not great, though Mocha has clearly a lower bearing potential than the other four selections. SL 18 heads the list, but the mean yield is only just significantly greater than that of Meru Kents which in general has cropped rather more regularly than other varieties in the trial.

KIRINDINI, IGEMBE, MERU. 4,200 feet.

When the full-scale trials were planted in 1951 at Meriga Mieru and Kiriani, subsidiary trials were laid down to observe in less detail how the various selections performed under different ecological conditions. These were called "miniature trials" since there were only single trees per plot.

TABLE LI

Annual yields 1955-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1955-1961*
SL 28	8.65	23.67	No Crop	15.31	5.60	9.72	13.87	10.97
Meru Kents	6.72	14.42		10.31	8.58	7.99	10.96	8.43
N 39	7.29	13.02		11.36	6.30	5.80	13.04	8.12
Dalle	8.77	12.96		7.44	7.67	6.44	7.15	7.20
Blue Mountain	5.41	13.99		7.80	4.71	5.47	9.96	6.76
Mean	7.37	15.61		10.44	6.57	7.08	11.00	8.30
Coefficient of variation %	32.78	31.21		55.42	52.30	45.03	39.37	17.53
Least significant difference								
p=0.05	3.31	6.69		7.94	4.72	4.38	5.94	2.00
p=0.01								2.81
p=0.001								3.97

The 5 × 5 Latin Square at Kirindini has shown that SL 28 can yield well at the altitude of 4,200 feet and has provided useful information on the performance of N 39 under these conditions. Meru Kents has cropped fairly consistently, but in common with all other selections seriously over-bore in 1956 and yielded nothing in 1957.

KAJIANDUTHI, MUTHAMBI, MERU. 4,600 feet.

A "miniature trial" planted as a 5 × 5 Latin Square in 1951. Unfortunately the variability of this trial has been too high to show up many significant differences between the varieties.

TABEL LII

Annual yields 1954-1961

(Cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6: 1)

Variety	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1954-1961*
Meru Kents	14.55	22.11	6.23	18.36	16.64	14.53	18.14	15.34	15.74
SL 28	16.70	24 56	4.94	15.17	7.48	8.84	17.48	14.38	13.69
SL 18	9.00	23.52	11.10	12.16	14.21	3.42	12.32	12.74	12.31
Series L	12.76	20 84	5.91	12.83	5.12	12.95	13.30	10 87	11.82
Mocha	10.62	15.31	6.58	6.82	9.24	0.79	8.63	11.35	8.67
Mean	12.73	21.27	6.95	13.07	10.54	8.11	13.97	12.94	12.45
Coefficient of variation %	51.75	41.49	86.33	45.65	59.93	142.60	66.28	43.17	22.07
Least significant difference									
p=0 05	9.04	12.11	8.23	8.19	8.67	15.87	12.71	7.67	3.77
p=0 01									5.31
p=0.001									7.51

The poor performance of Mocha confirms the results of the Kiriani Trial, but although Series L has yielded significantly less than Meru Kents, no difference may be distinguished between the mean annual yields of Meru Kents, SL 28 and SL 18.

KANUNI, LOWER IGEMBE, MERU. 4,100 feet.

This is the first of two "miniature" trials planted in 1954 at altitudes below the generally accepted coffee growing zone on Mount Kenya. The seven varieties are arranged in a Latin Square with single-tree plots.

TABLE LIII

Annual yields 1958-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	*1958*	*1959*	*1960*	*1961*	*1958-1961*
SL 14	15.04	6.78	5.60	6.24	8.42
Series L	17.76	3.08	7.23	2.53	7.65
SL 28	19.92	2.16	5.45	2.26	7.45
K 7	12.93	5.36	7.23	1.30	6.70
Kenya Selected	10.49	5.81	7.59	2.54	6.61
Barbuk Forest	5.52	5.06	6.29	0.00	4.22
Columnaris	7.98	1.54	3.29	0.00	3.20
Mean	12.81	4.26	6.10	2.12	6.32
Coefficient of variation %	42.11	64.50	44.35	150.16	29.31
Least significant difference					
p=0.05	5.89	3.00	2.95	3.47	2.02
p=0.01	7.93	4.04	3.98	4.68	2.72
p=0.001	10.51	5.35	5.27	6.20	3.61

From the rather erratic results of this trial few differences can be shown to be statistically significant, however Barbuk Forest and Columnaris have been consistent in their poor performances. The resistance of K 7 to Race II of Leaf Rust has not yet been evident in its effect on the yield of coffee. This selection has shown a greater tendency to biennial bearing than Series L, SL 14 or SL 28.

NGERU, LOWER MWIMBE, MERU. 4,000 feet.

The second of the two low-altitude trials is of the same design as the Kanuni trial, and unfortunately has been almost as irregular.

TABLE LIV

Annual yields 1957-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	*1957*	*1958*	*1959*	*1960*	*1961*	*1957-1961*
Series L	10.63	7.58	13.81	12.03	4.27	9.66
K 7	3.66	10.83	8.60	21.98	3.12	9.64
SL 14	3.74	9.24	16.90	11.19	4.82	9.18
SL 28	5.44	4.00	14.50	14.28	3.13	8.27
Kenya Selected	8.93	8.84	6.97	13.51	1.76	8.00
Barbuk Forest	0.59	3.90	4.98	10.06	1.30	4.17
Columnaris	0.21	4.98	1.58	8.67	3.87	3.86
Mean	4.74	7.05	9.62	13.10	3.18	7.54
Coefficient of variation %	83.19	64.53	57.40	30.54	98.25	22.02
Least significant difference						
p=0.05	4.30	4.97	4.38	2.66	3.41	1.81
p=0.01	5.80	6.69	5.90	3.59	4.59	2.44
p=0.001	7.68	8.87	7.82	4.76	6.09	3.24

From the mean annual yields for the five seasons recorded only Barbuk Forest and Columnaris can be shown to be significantly different from the other varieties, but the yields from K 7 show a biennial bearing characteristic even more marked than at Kanuni.

AGRICULTURAL INVESTIGATION CENTRE, EMBU. 4,900 feet.

This full-scale trial has nine-tree plots and is representative of the lower margin of the coffee growing zone of the district. The trial was planted in 1950 according to a Latin Square design and has now been recorded for nine seasons.

TABLE LV

Annual yields 1953-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6:1)

Variety	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1953-1961*
SL 14	9.20	22.36	15.41	11.23	5.73	12.88	7.09	4.76	4.91	10.40
SL 28	10.35	18.89	13.64	13.36	3.72	13.59	5.56	4.54	7.14	10.09
SL 34	12.36	18.94	13.41	13.51	4.43	13.62	3.19	3.45	6.63	9.95
N 197	9.47	16.65	14.41	10.20	3.68	11.04	4.16	4.29	5.56	8.83
Kents	10.52	14.96	12.38	10.80	3.61	9.63	3.54	3.14	4.72	8.14
Mean	10.38	18.36	13.85	11.82	4.23	12.15	4.70	4.04	5.79	9.48
Coefficient of variation %	22.20	17.89	29.20	12.50	21.60	15.10	29.70	32.80	32.20	7.95
Least significant difference										
p=0.05	3.36	4.79	5.90	2.15	1.33	2.68	2.04	1.93	2.72	1.10
p=0.01	4.89	6.97	8.58	3.14	1.94	3.89	2.96	2.81	3.96	1.60
p=0.001										2.40

The general level of cropping has deteriorated badly since 1958, however the three SL selections have maintained their superiority over N 197 and Kents. From the 1961 yields it would appear that SL 28 and SL 34 are regaining their productive capacity more quickly than the other selections.

Southern Province

MACHAKOS DISTRICT

In 1954 a series of "miniature" trials was planted in areas thought to be suitable for coffee growing. It proved impossible to maintain any large-scale trial and the coefficient of variability for the miniature trials now shows that they were irregular and cannot be expected to provide results of much precision. The irregularities would have been minimised if the trials had been recorded each year, but as may be seen in Table LVI no trial has been recorded each year since it first came into production in 1958.

All available results are gathered together in Table LVI although there is no difference of statistical significance. These are the only reliable records to indicate the cropping level of coffee in the district and have been gathered by the Field Staff of the Agricultural Department. SL 14 and SL 28 are represented in many of the trials and both have proved quite reliable, however from the scant evidence available it appears that K 7 has not yielded well.

TABLE LVI

Annual yields 1959-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	TRIAL SITE PLANTING DATE																			
	Iveti 6,100 Mulee Ngila November 1954		Iveti 6,050 William Mutisya November 1954		Mukaa 5,900 Mekeku Kyeu November 1954		Mbooni 2 5,880 Elijah Masumi April 1954	Mukaa I 5,750 Thomas Mbuvi November 1954		Iveti 5,700 Daniel Musau November 1954		Mukaa 2 5,600 Joel Nzioka November 1954			Mukaa I 5,500 Simeon Kaleli November 1954		Mukaa I 5,500 A. I. M. Kitaingo November 1954			Mbooni 3 5,400 Solo Kiamba April 1954	Mbooni Solomon Ndeto April 1954
	SEASON																			
	1960	*1961*	*1960*	*1961*	*1959*	*1961*	*1960*	*1959*	*1960*	*1960*	*1961*	*1958*	*1959*	*1960*	*1959*	*1960*	*1958*	*1959*	*1960*	*1960*	*1959*
SL 9	—	—	—	—	6.75	3.63	13.42	10.17	9.75	9.19	5.59	23.49	9.63	11.99	—	—	—	—	—	—	6.95
SL 14	—	—	8.47	8.87	5.27	4.79	—	8.15	7.51	8.39	5.43	12.30	10.81	8.79	9.19	12.30	6.91	4.47	7.47	10.31	—
SL 17	—	—	—	—	—	—	9.75	—	—	—	—	—	—	—	—	—	1.87	4.23	2.32	—	12.14
SL 28	—	—	—	—	—	—	10.86	8.55	6.71	8.31	6.43	20.77	7.07	9.27	11.35	6.79	0.64	2.08	2.56	6.59	13.26
SL 34	2.80	4.47	—	—	3.28	5.94	—	8.47	7.19	8.95	3.92	28.76	8.97	10.87	24.69	7.83	3.36	6.55	6.71	—	—
Kenya Selected 'A'	9.51	4.79	7.83	7.43	—	—	9.83	8.19	6.87	6.55	5.91	19.18	7.19	11.50	14.38	10.87	8.51	6.56	2.64	5.36	4.39
Series 'L'	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7.11	—
K7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7.62	3.40	—	—	—	6.09	—
Kents	10.55	9.43	7.99	7.75	2.64	3.35	10.31	—	—	—	—	—	—	—	—	—	—	—	—	—	4.31
Ke 20	8.79	2.88	10.07	7.23	2.98	3.62	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Blue Mountain	2.96	5.11	9.75	2.44	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Means	6.92	5.34	8.82	6.74	4.18	4.27	10.83	8.71	7.61	8.28	5.46	20.90	8.73	10.48	13.45	8.24	4.26	4.78	4.34	7.09	8.2
Coefficient of variation %	—	58.57	—	69.75	62.59	31.92	36.87	28.07	73.05	—	33.07	—	39.61	35.66	—	67.97	—	96.70	103.13	55.84	—

Coast Province

WUNDANYI, TAITA. 5,400 feet.

There are six trees per plot in this 6 × 6 Latin Square which was planted in 1950. Eight crops have been recorded and the average yield has ranged from 27.32 cwt. clean coffee per acre in 1959 to 3.19 cwt. in 1961, but between the mean annual yields for the six varieties there is no statistically significant difference.

TABLE LVII

Annual yields 1954-1961

(cwt. clean coffee per acre)

Variety	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1954-1961*
SL 34 . .	9.30	17.97	4.78	9.40	3.97	32.82	15.32	3.03	12.07
K 7 . .	10.74	18.08	3.98	7.90	2.97	25.12	20.26	2.88	11.49
KP 532 . .	9.58	19.42	3.32	9.37	3.61	26.60	16.12	3.02	11.38
SL 28 . .	7.92	19.41	4.98	7.90	4.98	27.81	13.22	4.76	11.37
SL 6 . .	12.64	18.66	3.40	7.02	3.15	23.34	19.76	1.88	11.23
SL 14 . .	7.53	14.52	5.53	9.42	3.65	28.22	13.62	3.59	10.76
Mean . .	9.62	18.01	4.33	8.50	3.72	27.32	16.40	3.19	11.38
Coefficient of variation % .	34.00	19.50	31.51	31.10	31.05	33.17	17.66	43.33	14.31
Least significant difference p=0.05	3.94	4.23	1.64	3.18	1.39	10.91	3.49	1.66	1.96

This is one trial in which SL 6 has yielded well, but with the possible exception of 1960, the Leaf Rust resistance of K 7, KP 532 and SL 6 is not evident in terms of the yield of coffee from these selections.

Rift Valley Province

AGRICULTURAL EXPERIMENTAL STATION, KITALE. 6.200 feet.

There are 16 varieties replicated six times in randomised blocks with ten trees per plot. The trial was planted at the same time as the two on Kentmere Estate (Table XLV) and includes many of the selections represented in those trials. No attempt was made to control Coffee Berry Disease before 1961 when the trial was split to allow the comparison of the varieties with or without protective fungicide sprays. This trial is now comparable with Kentmere trial II.

The general level of cropping was far higher than at Kentmere, but it is not possible to distinguish between the productivity of the various Blue Mountain selections. At Kitale the two Geisha selections have outyielded all others, but as was shown in the Coffee Research Station Annual Report 1960/61 page 27 the bean size of these types is regrettably small.

The incidence of Coffee Berry Disease has become increasingly severe as is indicated by the deteriorating yields from SL 34, SL 28 and Kents. The copper sprays applied for the first time in 1961 were more effective in raising the yield of coffee at Kitale than at Kentmere. It appears that SL 2 and Kents, SL 28 and SL 34 responded particularly well to the fungicidal treatments, however it is interesting that even some of the Blue Mountain selections also yielded more where the trees had been sprayed.

TABLE LVIII

Annual yields 1958-1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	*1958*	*1959*	*1960*	*1961*	*1958-1961*	*1961 Sprayed*	*Response to Spraying*
	No sprays for C.B.D. control						
Geisha 1	14.37	6.76	17.66	5.96	11.19	7.07	+1.11
Geisha 9	8.55	11.34	9.29	7.92	9.28	8.88	+0.96
Blue Mountain N1	11.67	6.36	13.37	3.88	8.82	5.31	+1.43
Blue Mountain I5	11.67	4.85	15.23	3.36	8.78	2.84	—0.52
Blue Mountain P13	9.99	6.78	13.09	5.09	8.74	6.00	+0.91
Blue Mountain P8	11.22	6.69	12.73	4.30	8.74	5.92	+1.62
Blue Mountain K7	11.89	3.86	14.61	3.70	8.52	4.69	+0.99
Blue Mountain W12	11.63	4.38	14.80	2.66	8.37	2.53	—0.13
Kenya Selected	10.37	6.64	12.52	3.83	8.34	5.46	+1.63
SL 2	13.72	4.77	11.95	2.92	8.34	6.17	+3.25
Blue Mountain P12	11.47	3.65	13.76	2.80	7.92	4.68	+1.88
SL 1	11.80	3.60	11.24	4.72	7.84	5.43	+0.70
Blue Mountain Q6	11.94	2.61	13.11	3.08	7.69	1.66	—1.42
SL 34	12.49	5.33	6.28	3.52	6.91	5.32	+1.80
SL 28	14.85	2.21	8.25	2.22	6.88	4.45	+2.23
Kents	10.58	4.43	8.96	2.26	6.56	5.32	+3.06
Means	11.76	5.27	12.30	3.89	8.31	5.11	+1.22
Coefficient of variation %	17.67		16.60	39.59		49.79	
Least significant difference							
p=0.05	1.18		2.35	2.57		4.24	
p=0.01	1.58		3.12	3.46		5.71	

Nyanza Province

COFFEE RESEARCH SUBSTATION, KISII. 5,600 feet.

In 1950 this trial was planted on the "Kisii Farm" as a 7 × 7 Latin Square with nine-tree plots. The land was later incorporated in the Coffee Research Substation during 1957.

TABLE LIX

Annual yields 1953–1961

(cwt. clean coffee per acre using an assumed cherry : clean coffee ratio of 6 : 1)

Variety	*1953*	*1954*	*1955*	*1956*	*1957*	*1958*	*1959*	*1960*	*1961*	*1953–1961*
SL 14	1.57	8.22	2.71	14.10	5.30	5.64	15.32	13.15	11.87	8.65
SL 28	1.08	7.83	4.10	14.93	5.57	5.81	15.25	11.08	9.04	8.30
Kenya Selected	0.43	6.50	2.77	12.83	5.38	4.85	14.90	10.72	7.88	7.36
Kents	0.48	6.35	3.51	10.17	4.92	8.53	11.01	9.19	10.26	7.16
Thorolds	0.68	6.66	2.99	12.08	5.11	4.06	10 06	9.72	11.12	6.94
KIT 145	0.86	5.43	2.44	10.86	4.55	3.88	11.20	10.69	8.45	6.48
Blue Mountain	0.70	4.72	3.49	10.45	3.42	4.63	9.08	8.67	10.97	6.24
Mean	0.83	6.53	3.14	12.20	4.89	5.34	12.40	10.46	9.94	7.30
Coefficient of variation %	66.24	14.59	42.27	17.57	22.67	29.73	13.30	19.98	21.29	7.35
Least significant difference p = 0 05	0 60	1.04	1.62	2.34	1.21	0.78	1.80	2.28	2.31	0.59
p 0 01	0 81	1.40	2 18	3.15	1 63	1 05	2.42	3 07	3.11	0.79
p = 0.001	1.07	1.86	2.89	4.18	2.16	1.39	3.21	4.07	4.12	1.05

SL 14 and SL 28 have been the two outstanding selections in this trial, although other differences of statistical significance may be shown between the mean annual yields for the nine seasons 1953–1961. Since 1959 the performance of SL 28 has slightly deteriorated relative to the production of SL 14 and in fact for 1961 was significantly inferior in yield to that selection.

KEUMBU, KISII. 6,200 feet.

In 1951 this trial was planted as a 9 × 9 Latin Square with single-tree plots, but yields were not recorded before 1958 and therefore are only available for four seasons.

TABLE LX

Annual yields 1958–1961

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

Variety	*1958*	*1959*	*1960*	*1961*	*1958–1961*
SL 14	9.70	13.91	12.48	3.74	9.96
SL 34	9.07	14.58	10.82	3.11	9.40
Mocha	9.17	11.80	12.22	3.16	9.09
Thorolds	11.47	12.16	9.76	2.38	8.94
N 100	8.93	10.54	10.16	3.87	8.38
SL 28	9.37	13.00	8.04	2.50	8.23
Kenya Selected	8.87	11.15	9.67	2.59	8.07
Kents	8.09	9.94	8.35	2.14	7.13
SL 2	10.47	8.00	3.10	2.31	5.97
Mean	9.46	11.68	9.40	2.87	8.35
Coefficient of variation %	37.67	37.18	44.93	74.97	26.73
Least significant difference					
p = 0.05	3.36	4.09	3.98	2.02	2.10
p = 0.01	4.47	5.45	5.30	2.70	2.80
p = 0.001	5.81	7.08	6.89	3.51	3.64

Once again SL 14 heads the list, but the variability of the trial is such that only Kents and SL 2 can be said to be less productive than SL 14.

SHIKUSA, NORTH NYANZA. 5,000 feet.

Two large variety trials were planted at Shikusa in 1954, but only one has been recorded for yield. This is a 7 × 7 Latin Square with nine-tree plots each of which is split into three sub-plots to compare methods of pruning secondaries. Through some misunderstanding of the purposes of the trial yields were not recorded in 1961; however four crops had been weighed and the results are summarised in Table LXI.

SL 30 was originally included in this trial but was so badly attacked by Leaf Rust that it had to be uprooted. Its place was taken by K 7 for which only two years' results are available.

The general level of production from this trial has been very poor, but nevertheless the selections SL 14 and SL 34 have been shown to yield more than all the others except SL 2.

The most interesting part of the trial has been the pruning treatments. It is evident that the complete restriction of secondaries significantly depresses the crop production and that the least reduction of secondary growth has given the greatest yield of coffee.

TABLE LXI

Annual yields 1957–1960

(cwt. clean coffee per acre using an assumed cherry: clean coffee ratio of 6:1)

Variety and Pruning Treatments	*1957*	*1958*	*1959*	*1960*	*1957–1960*
SL 14	3.40	3.99	8.63	2.00	4.50
SL 34	3.21	5.46	7.28	1.62	4.39
K 7	—	—	5.31	2.10	3.71
SL 2	3.77	3.84	6.82	1.73	4.04
SL 28	3.13	4.14	6.05	1.49	3.70
Kapretwa Series 'A'	3.11	3.70	6.36	1.44	3.65
Kents	2.91	4.34	4.89	1.83	3.49
Coefficient of variation %	52.23	44.66	39.77	41.90	21.74
Least significant difference					
p = 0.05	1.08	1.19	1.62	0.46	0.54
p = 0.01	1.45	1.61	2.19	0.62	0.73
All secondaries removed	3.03	3.39	6.22	1.54	3.57
Secondaries removed for first crop on each primary	3.25	3.14	7.09	1.99	3.92
Secondaries removed only from proximal 1 ft.	3.49	6.20	6.12	1.70	4.34
Mean	3.26	4.24	6.48	1.74	3.94
Coefficient of variation %	30.77	51.50	34.05	48.52	20.33
Least significant difference					
p = 0.05	0.40	0.48	0.89	0.34	0.32
p = 0.01	0.53	0.63	1.18	0.45	0.43

MISCELLANEOUS STUDIES

Herbicides

Between 1956 and 1960 research was concentrated on the chemical control of *Digitaria scalarum* which was shown to be possible using dalapon. This herbicide is now in limited use on coffee plantations.

During 1960 and 1961 a series of trials was carried out to investigate the efficiency of residual herbicides. These were mainly of the substituted urea and triazine derivative groups, but Fenac and EPTC were also tested.

The trials in 1960 indicated that Fenac, "Alipur" (OMU + BiPC) and Monuron were the most promising of the 19 herbicides studied. In 1961 very good weed control was achieved using mixtures of herbicides, but no one chemical was found to be both safe and satisfactory. Amitrole/triazine mixtures were very promising and of the triazines tested methoxy-propazine was the most consistently effective although Simazine often gave a longer control of weed growth. These trials have been fully reported in Pesticides Abstracts and News Summary Section C.

Spraying Machinery

Sprayers imported into Kenya and considered likely to be suitable for use by coffee growers have been examined at the Coffee Research Station. Reports have been prepared in each case and submitted to the manufacturers through the local agents. It is satisfactory to record that modifications suggested have frequently been incorporated into the design of the equipment.

Droplet spectra have not been analysed, but spray penetration and distribution are regularly assessed. These studies have provided a basis for advice to coffee growers on the relative merits of comparable sprayers.

AGRICULTURAL CHEMISTRY

COMBINATION OF THE PHOSPHORUS DIGESTION AND DETERMINATION WITH POTASSIUM, CALCIUM, MAGNESIUM DETERMINATIONS

Two different methods have been employed in the laboratory, one for the determination of phosphorus and another for potassium, calcium and magnesium. The phosphorus method involves digestion with nitric acid followed by sulphuric-perchloric acid mixture (1). The method for potassium, calcium and magnesium involves ashing in a muffle furnace followed by dilute hydrochloric acid digestion. It has now been found that the digest used for phosphorus determination can also be used for determinations of the other elements, a valuable and time-saving discovery.

The results for the two methods are given in Table LXII. The differences between the two methods were not significant.

TABLE LXII

Analytical Methods Compared

		Mean	*Signi-ficance*
% Mg in dry matter	a) 0.25 0.45 0.40 0.22 0.25 0.17 0.16 0.46 0.45 0.17 0.40 0.50 0.19 0.33 0.40 0.18 0.28	0.44	N.S.
	b) 0.24 0.44 0.40 0.21 0.24 0.17 0.16 0.42 0.49 0.16 0.41 0.56 0.20 0.30 0.33 0.16 0.29	0.43	
% Ca in dry matter	a) 1.49 1.40 1.38 1.64 1.45 1.90 1.40 0.98 1.30 1.61 0.98 1.16	1.39	N.S.
	b) 1.48 1.34 1.54 1.64 1.23 1.86 1.34 0.93 1.30 1.54 0.92 1.13	1.35	
% K in dry matter	a) 2.42 2.61 2.42 2.33 2.38 2.74 1.80 1.83 2.14 2.05 1.99 2.17	2.24	N.S.
	b) 2.43 2.58 2.44 2.38 2.44 2.70 2.03 2.09 2.05 2.18 2.00 2.20	2.27	

a = Ashing method b = Wet acid digestion

LEAF PHOSPHORUS

Leaf samples analysed from various trials at the Coffee Research Station have shown that water availability has a great influence upon leaf phosphorus values.

Influence of a Napier Grass Mulch on Coffee Leaf Phosphorus

Leaf samples were collected at monthly intervals during 1960 from the Mulch and Soil Regeneration Trial. First mature leaf samples and leaves from second bearing node were sampled from plots receiving 46 lb. nitrogen per annum as sodium nitrate and as ammonium sulphate nitrate. Both unmulched and mulched plots were sampled.

The overall mean leaf phosphorus values are summarised in Table LXIII.

TABLE LXIII

Mean leaf phosphorus values as % element in leaf dry matter

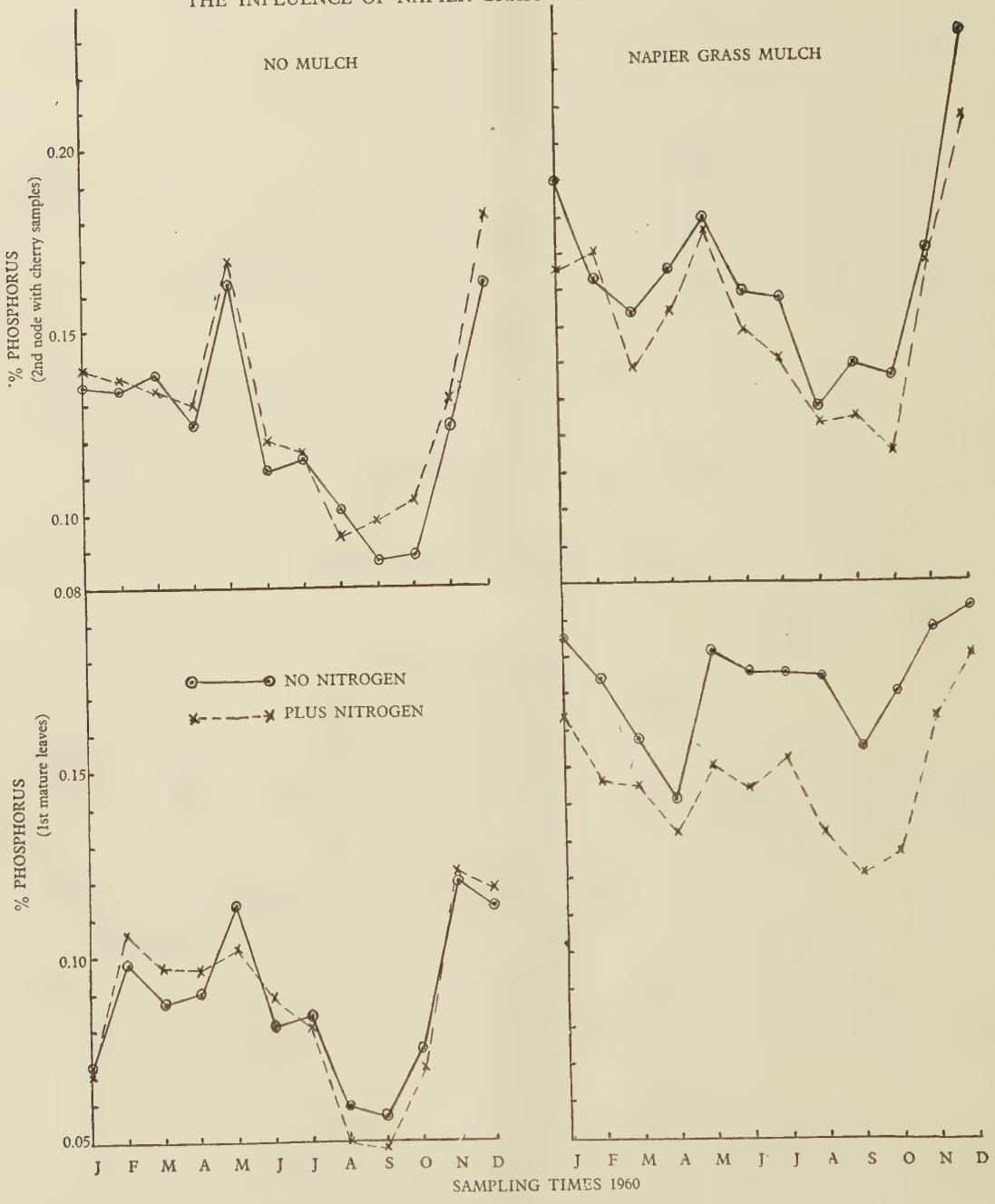
		No Nitrogen	*Sodium Nitrate*	*Ammonium Sulphate Nitrate*
First mature leaf	No mulch	0.1236	0.1241	0.1296
	Napier Grass mulch	0.1641	0.1512	0.1523
Second bearing node leaf	No mulch	0.0874	0.0867	0.0874
	Napier Grass mulch	0.1722	0.1454	0.1463

Napier Grass mulch has increased leaf phosphorus values in both the first mature and second bearing node leaf sampl s. This finding is in agreement with results reported previously (2).

Figure 1 shows the variation of leaf phosphorus with sampling time in presence or absence of a mulch. Mulch has increased leaf phosphorus over the sampling period. This effect is highly marked in the older leaves (second bearing node samples.)

Fig. 1

THE INFLUENCE OF NAPIER GRASS MULCH ON LEAF PHOSPHORUS



Leaf samples collected at monthly intervals during 1960 from Manurial Trial IV have similarly shown the effect of mulching on leaf phosphorus.

The overall mean phosphorus values for this trial are given in Table LXIV.

TABLE LXIV

Phosphorus content as % element in leaf dry matter

	No mulch	*Napier Grass mulch (Alternate inter-row)*	*Napier Grass mulch (In-row-every row*	*L.S.D's 2 means of (20)*
First mature leaves	0.1378	0.1491	0.1530	0.012**
Fourth leaf samples	0.1314	0.1359	0.1453	0.009**
First and second bearing node leaf samples	0.1108	0.1172	0.1260	0.011**

The variation of leaf phosphorus with sampling time in this trial is given in Figure 2b.

Influence of Irrigation on Coffee Leaf Phosphorus

Fourth leaf samples were collected at monthly intervals during 1960 from control plots and from plots receiving 46 lb. nitrogen per annum as ammonium sulphate nitrate in the Irrigation Trial (overhead irrigation applied whenever necessary). Both irrigated and non-irrigated plots were sampled.

The mean leaf phosphorus values over the whole sampling period are given in Table LXV.

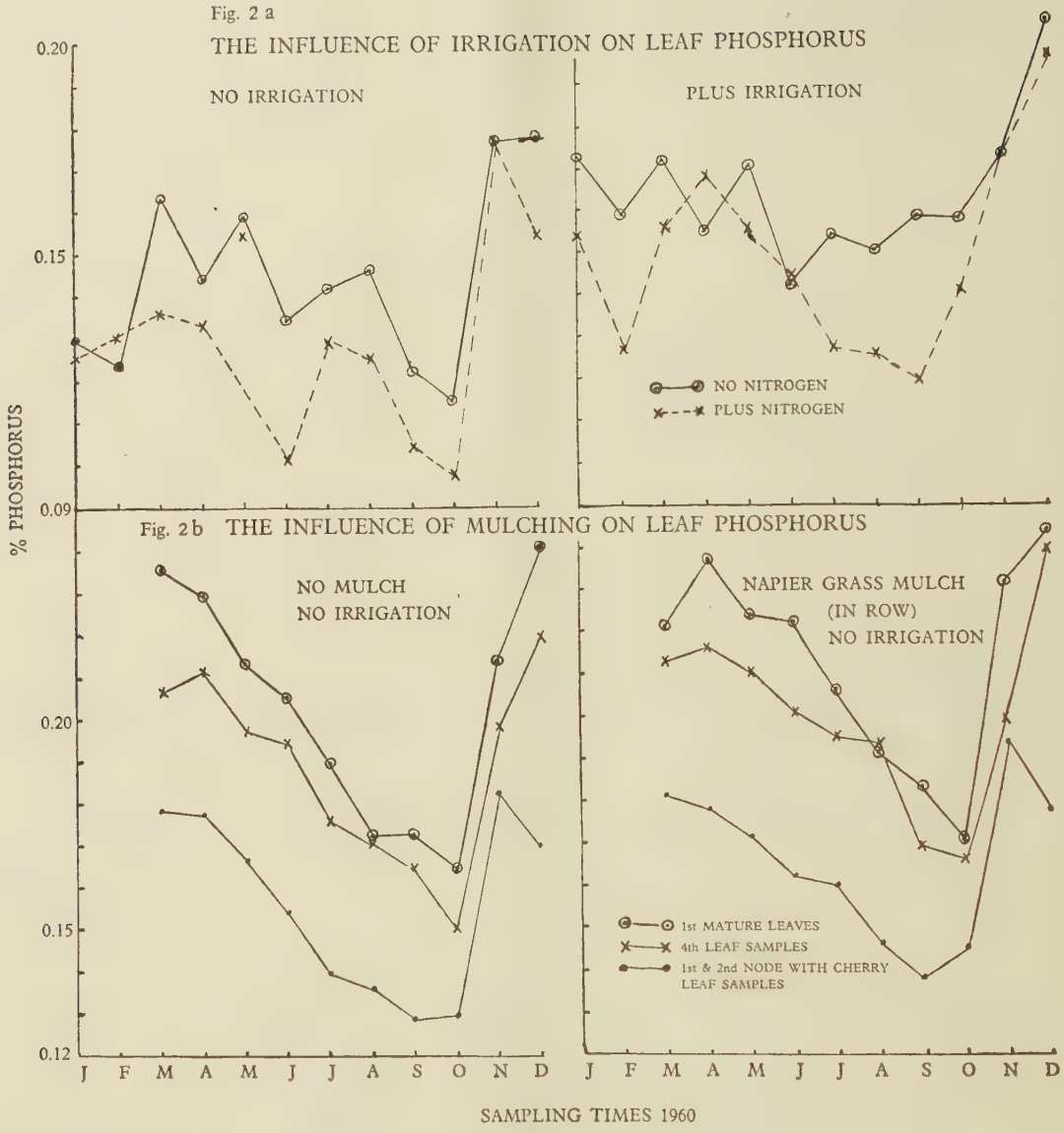
TABLE LXV

Phosphorus content as % element in leaf dry matter

	No Irrigation	*Plus Irrigation*
No nitrogen	0.1444	0.1638
Plus nitrogen	0.1305	0.1489
L.S.D.'s 2 means of (36)	0 009*	—
	0.012**	—
	0.016***	—

The variation of leaf phosphorus with sampling time is given in Figure 2a. The effect of irrigation has been to maintain high leaf phosphorus values over the whole year including the dry period. During the rains, phosphorus levels are found to be high with or without either mulch or irrigation.

The Irrigation Trial is also mulched (alternate-row mulch applied in March). From the two Figures I and 2a it is found that the interaction of nitrogen fertilizer and mulch has decreased the leaf phosphorus over the whole sampling period.



Phosphorus Deficiency in Coffee Leaves

Leaf samples from a plot of coffee exhibiting symptoms of phosphorus deficiency were analysed for phosphorus content. On leaves showing no deficiency symptoms, values of P content varied from 0.1609% element in leaf dry matter on the first mature leaf pair, down to 0.0929% in the twelfth pair. Leaves showing deficiency symptoms gave values of 0.0529% in first mature leaves, down to 0.0390% in the twelfth pairs, and were consistently lower than in adjacent leaves not showing phosphorus deficiency symptoms.

LEAF NITROGEN

The mean leaf nitrogen values for the first mature, fourth leaf pair and from first and second bearing node leaf samples, from Manurial Trial IV are presented in Table LXVI.

TABLE LXVI

Mean leaf nitrogen (% element in leaf dry matter)

	No mulch	*Napier Grass mulch (alternate row)*	*Napier Grass mulch (in-row)*	*L.S.D. 2 means of (20)*
First mature leaves	2.030	2.106	2.132	N.S.
Fourth leaf samples	1.882	1.935	2.000	0.089**
First and second bearing node leaves	1.555	1.587	1.651	0.067**

The presence of a mulch has significantly increased the leaf nitrogen levels over the controls in the case of fourth leaf samples and the first and second bearing node leaves. A similar mulch effect was reported in the 1690/61 Annual Report (p. 36).

The variation of leaf nitrogen with sampling time in this trial was found to be similar to that reported in the 1960/61 Annual Report (p. 36), the nitrogen levels being at a minimum during the dry period.

The Influence of Irrigation on Leaf Nitrogen

Leaf samples from the Irrigation Trial were analysed for nitrogen, and its variation with sampling time is given in Figure 3 and the mean values are given in Table LXVII.

TABLE LXVII

Mean leaf nitrogen (% element in leaf dry matter)

	No Irrigation	*Plus Irrigation*
No Nitrogen .	1.891	1.913
Plus Nitrogen .	1.928	1.920

Irrigation in presence or absence of a nitrogen fertilizer has resulted in lowered nitrogen values over the Long Rains from March.

The levels in the dry September/October months, however, are considerably higher. The overall mean nitrogen values are only slightly increased by irrigation. In this particular case the nitrogen fertilizer application raised leaf nitrogen levels only slightly on both the irrigated and unirrigated plots.

LEAF MAGNESIUM

Leaf samples collected at monthly intervals during 1960 from plots receiving an annual application of 40 lb. magnesium per acre as magnesite or kieserite in Manurial Trial VI have been analysed for magnesium. Fourth leaf samples and second bearing node leaf samples were collected.

The overall mean magnesium values are presented in Table LXVIII.

TABLE LXVIII

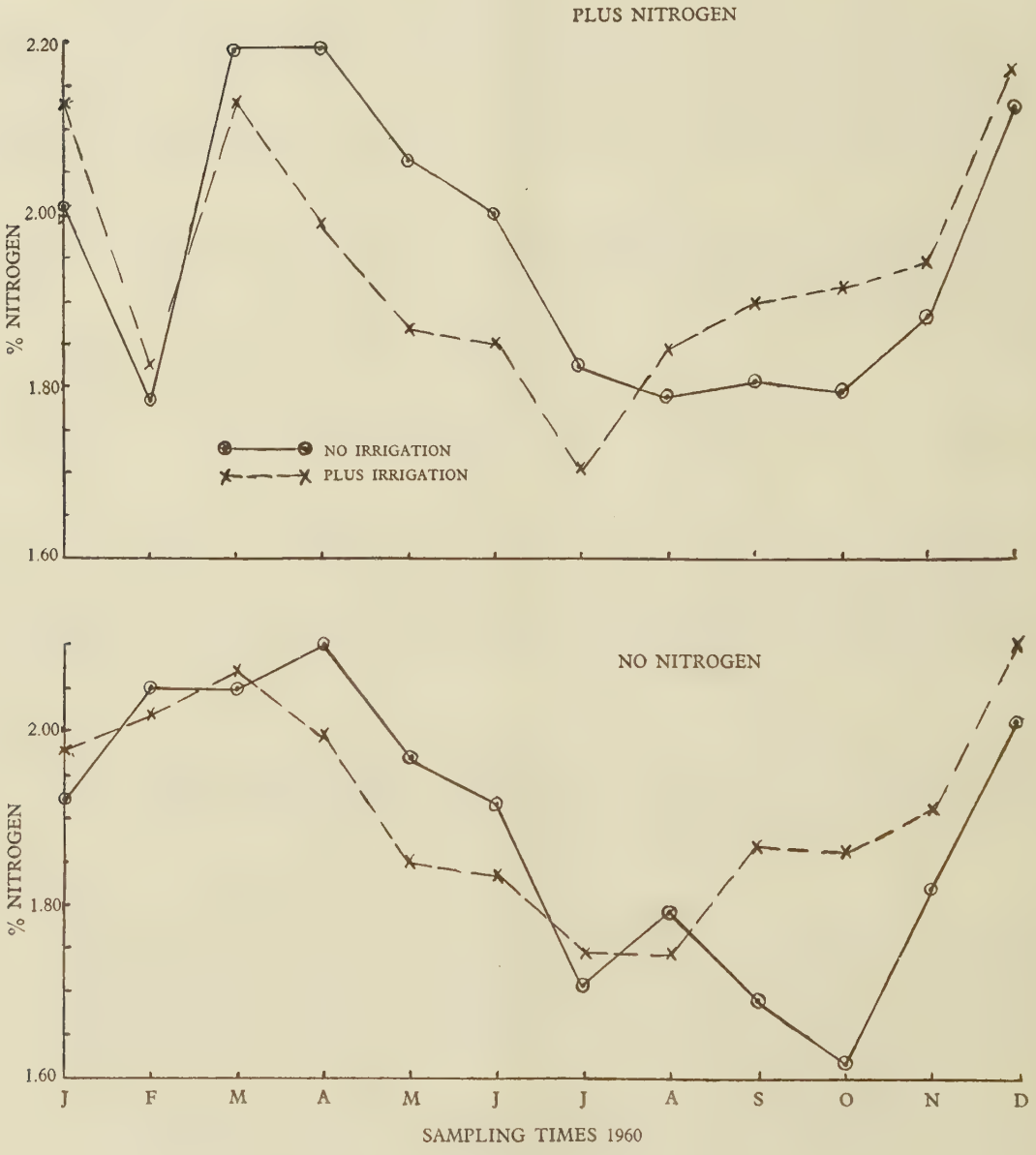
Mean leaf magnesium (% element in leaf dry matter)

	No Magnesium	*40 lb. Mg. as magnesite*	*40 lb. Mg. as kieserite*	*80 lb. Mg. magnesite + kieserite*
Fourth leaf samples	0.43	0.45	0.45	0.45
Second node with cherry leaf samples	0.42	0.47	0.45	0.46

Leaf magnesium levels in this trial were found to be generally high. Annual application of 80 lb. magnesium per acre only very slightly raised leaf magnesium levels, the effect being greater in the older leaves (second node-with-cherry leaf samples).

Fig. 3

THE INFLUENCE OF IRRIGATION ON LEAF NITROGEN



MICRO-NUTRIENTS

Leaf samples from the Coffee Research Station and substations have been analysed spectrographically for the last two years. The mean levels are not dissimilar from those obtained in Brazil (3).

TABLE LXIX

Leaf Micro-element values (parts per million)

Elements in p.p.m.	*Iron*	*Manganese*	*Boron*	*Zinc*
Upper Kiambu unshaded	181	111	47	14.2
„ „ shaded .	180	167	45	11.4
Kitale shaded . .	180	205	50	11.5
„ shade and mulch .	183	156	58	21.3
Ruiru (C.R.S.) mulched	220	210	76	11.8
„ „ unmulched	192	182	85	8.6
Koru unshaded . .	147	161	60	15.2
„ shaded . .	170	184	51	9.6
Kisii	170	180	71	9.0
North Kitito . . .	135	218	39	10.5

References

(1) Piper, C. S. Phosphorus method.

(2) Ann. Report C.R.S. 1959/60, p. 58.

(3) Medcalf, J. C. and Lott, W. L. Metal Chelates in Coffee, *I.B.E.C. Research Inst. Bulletin* No. 11.

PLANT PHYSIOLOGY

Growth of the Coffee Berry

The growth of the coffee berry was studied as part of the investigations into the carbohydrate status of the tree and the problem of overbearing.

Fig. 4 a, b and c presents the fresh weight, the dry weight and the percentage of dry matter of a coffee berry, its pulp and its beans as a function of the time elapsed since flowering. The data are obtained from berries resulting from a concentrated flowering in November 1960. These berries ripened earlier than usual and therefore it will often be found that the life cycle of a berry is longer than shown in Fig. 4 a, b and c. The weights of the berry as a whole are factual observations. The weights of the beans and the pulp are calculated, being based on the relations found between the fresh and dry weights of berry, pulp and beans in 1,280 berries studied for this purpose.

From Fig 4a which pictures the increase in fresh weights, it can be seen that after an initial period of approximately seven weeks in which growth is slow, a second period follows in which growth of the berry is very rapid, until about 16 weeks after flowering. It seems that a small drop in fresh weight recurs approximately 17 weeks after flowering. This feature was found when studying berries resulting from three different flowerings and, consequently, seems to be no experimental error. A fourth period follows in which only a little increase in fresh weight can be measured. Then, when the colour of the berry begins to turn from green to yellow, a rapid gain in weight is achieved. The drop in fresh weight after 34 weeks is the result of the drying on the tree of an over-ripe berry.

The dry weight of a berry develops in a way which is different from that of the fresh weight, (Fig. 4b). The same initial period of very slow growth is similarly followed by a period of rapid growth but the increase in dry weight is much less pronounced than the increase in fresh weight. The drop in fresh weight, about 17 weeks after flowering, is reflected in the dry weight where it remains constant for a short while. Then, growth is resumed and accelerates once more as ripening begins.

The length of the first period of very slow growth is reduced under moist conditions. There are strong suggestions that, in the second period, the speed of increase in fresh weight is favoured by good rains but that such rains have little or no effect on the increase in dry weight. Consequently, wet conditions in the period between seven and 17 weeks after flowering seem to stimulate the formation of larger berries with a high moisture content which take a longer time to ripen.

Studying beans and pulp + parchment separately, it can be seen that the fresh weight of the beans hardly changes once the berry is 17 weeks old. At that time, the parchment begins to harden and the final size of the beans is laid down. Water is replaced by dry matter until the final dry weight is reached at the time when the skin changes colour, which is approximately five to six weeks before picking.

Both fresh and dry weight of the pulp + parchment increase slightly from 17 weeks after flowering onwards until ripening begins. At that time not only the fresh weight but also the dry weight increases considerably. During the last 39 days before the stage of full ripeness, gains of 106% in dry weight of the pulp + parchment and of 49% for the berry as a whole were found.

Carbohydrate Studies

(a) Sampling for the experiment designed to study the levels of carbohydrates and mineral elements in various parts of the tree has finished. Analysis of the samples collected is awaiting completion.
(b) The method whereby the amount of starch in the wood is estimated after staining a section with iodine and assessing the intensity of the developing blue colour has yielded very useful information.

In one experiment, the quantity of starch was studied in primaries carrying their first crop. At the beginning of the observations (20th October, 1960) primaries were selected which were situated at the 10th node counted from the top of the main stem to which they were attached. By the end of the experiment (16th October, 1961), and as a result of the growth in height of the main stem, they were at the 22nd node of the main stem.

Fig. 4a Fresh weight, dry weight and percentage of dry matter of beans, pulp and whole berry as functions of time

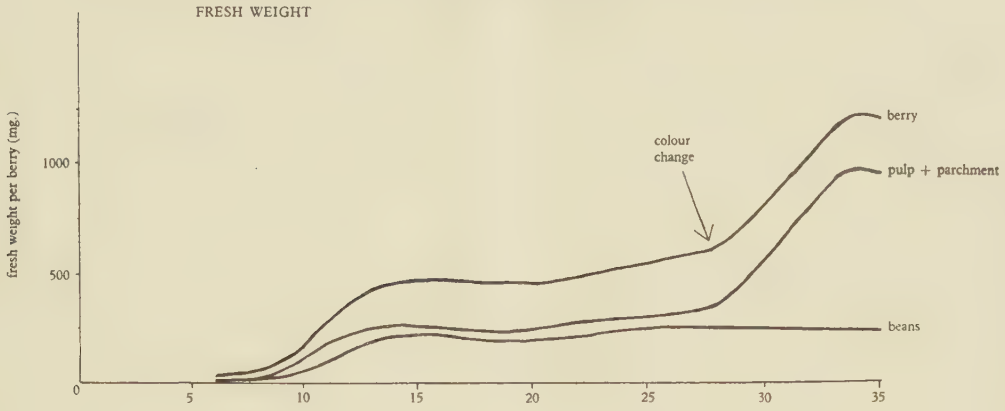


Fig. 4b DRY WEIGHT

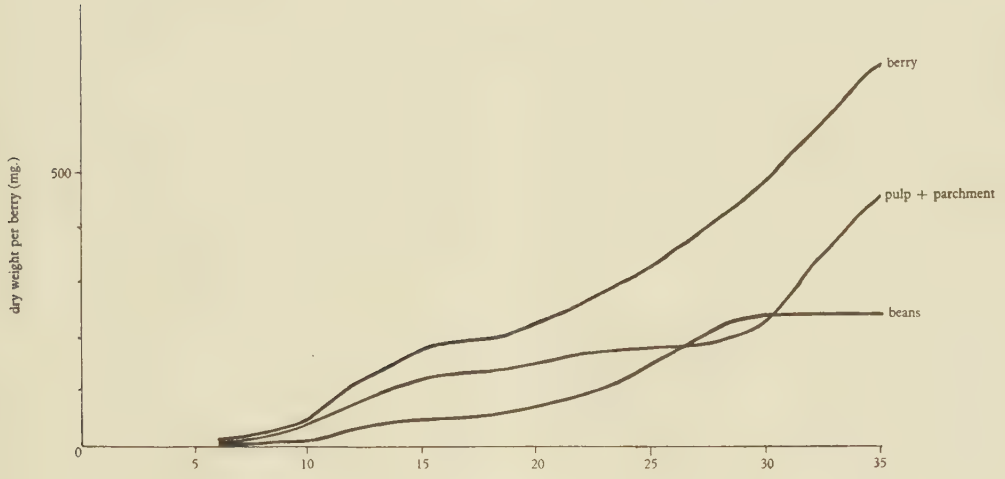


Fig. 4c % DRY MATTER

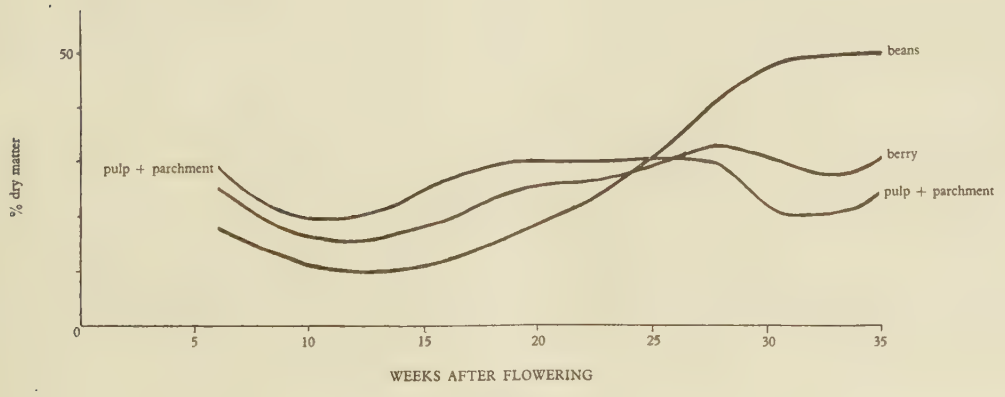


Fig. 5a Amount of starch in wood and increase in weight of berry as functions of time

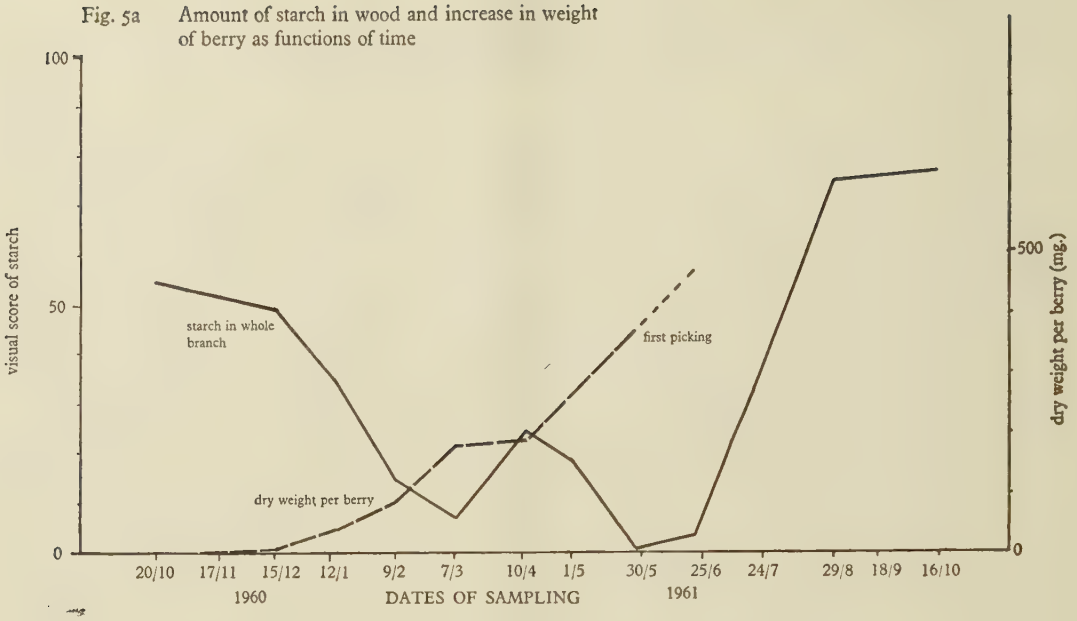
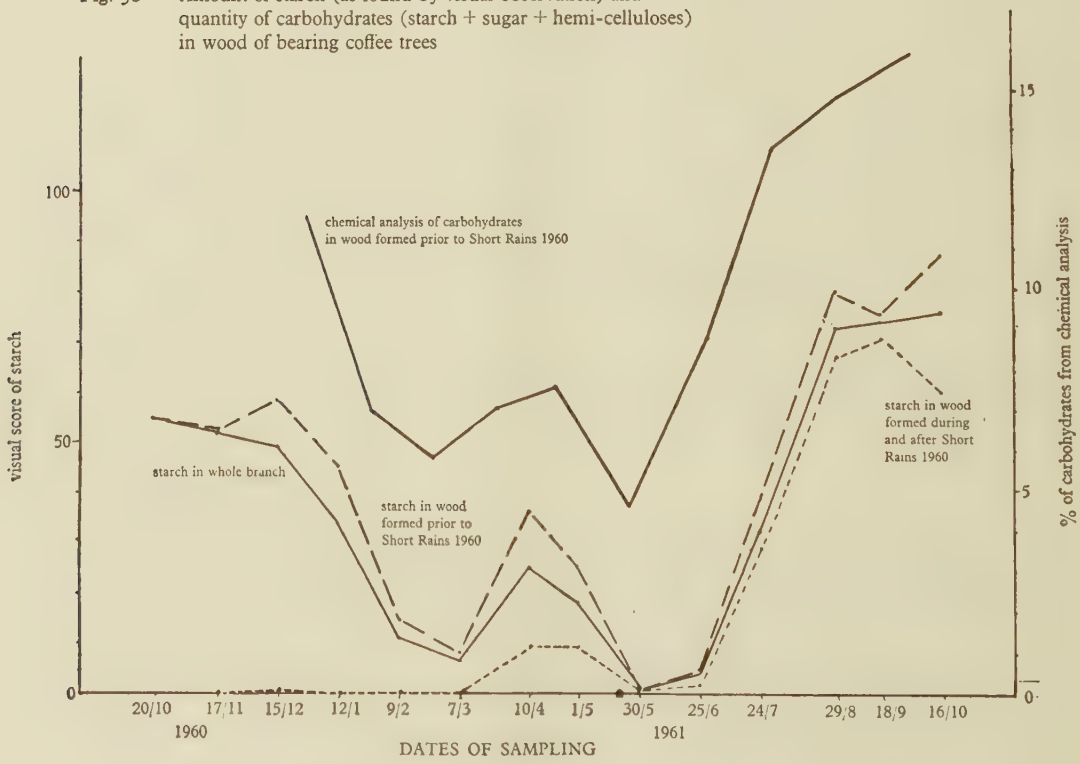


Fig. 5b Amount of starch (as found by visual observation) and quantity of carbohydrates (starch + sugar + hemi-celluloses) in wood of bearing coffee trees



Figs. 5a and b summarise the more important results of the observations. Agreement between results obtained by chemical analysis and by visual means is very satisfactory. Differences like, e.g., on 25th June, 1961, must be explained by the presence of important quantities of sugars not yet converted into starch and, consequently, not seen in the visual assessment.

Fig. 5a shows how the development of the quantity of starch in the wood is closely related to the growth of the berries. The reduction in the speed of growth of the berry in March and April is immediately reflected in the increasing amount of starch in the wood. The same observation can be made when, after 30th May, part of the crop is picked, enough to enable the tree to start building up its food reserves again. It must be kept in mind that the development of the weight of the berry cannot be fully compared with Fig. 5b as the berries on the branches used for the observations came from two different flowerings.

The time of the first sharp decline in the amount of starch present in the wood is the period of rapid growth of the berry and also a period in which an important loss of young berries occurs. Afterwards, berry drop is negligible. Thus, the tree has to feed a fixed number of berries, the size of which is already laid down. It seems likely that so-called "lights" (shrivelled beans in capacious cavities) are formed when, owing to insufficient reserves and/or unfavourable conditions for synthesizing new supplies, the tree cannot meet the requirements of the beans. The familiar symptoms of overbearing towards the end of the growth cycle of the berry, can be explained by the heavy demands of the ripening pulp at a time when food reserves are very low, while the tree cannot relieve itself by shedding the excess of crop it carries.

From Fig. 5b it can be seen that the young, non-bearing part of the branch follows the downward trend of the quantity of starch in the bearing wood. Other observations make it clear that such young wood would have built up some starch prior to March if it had not been prevented from doing so by the growth of the berries borne on the older wood. In separate experiments, it was shown that starch in non-bearing primaries, higher up the tree, followed the same trend as starch in bearing wood, but both maximum and minimum values were higher. The interdependence of the various parts of the tree is equally proved by the incomplete results of the experiment mentioned under (a). On the other hand, sometimes a considerable difference in the quantity of starch could be found between cropping and non-cropping parts of the same branch. It was also observed that levels of starch can be very different in neighbouring internodes of which one has, and the other one has not, carried some berries even when the observation is done several months after picking the crop. These contradictory findings demand a more detailed investigation.

Observations made on secondaries showed that, similarly as in tips of primaries, only the apical two or three internodes are without starch. Even in very young secondaries, the third, fourth and, if present, the older internodes, can contain a not inconsiderable quantity of starch. Apart from storing starch in their own internodes, secondaries do contribute to the amount of starch in the primary to which they are attached. In a small-scale experiment, all secondaries were removed from the basal part of an old primary. This basal part did not carry a crop and was devoid of leaves. On similar wood, all secondaries appearing (which were too young to flower) were allowed to grow unrestricted. After a period of nine months, scoring of the quantity of starch in the lowermost 20 internodes gave an average value of 36% in the wood on which the secondaries were left against 9% in the wood from which the secondaries had been removed. There was a suggestion that the amount of starch in the primary increased with a higher total of nodes of all the secondaries until a certain maximum was reached, after which a higher density of secondaries could be a disadvantage.

It could be objected that the method by which starch scores on individual internodes are added and their mean value taken as representative of the branch as a whole, does not consider length of the internode and area of the pith. Length of the internode is the more variable of the two factors. Calculations have shown that inclusion of the area of the pith and/or (only) the length of the internodes, gives different results as could be expected. Differences are, however, not very important and it cannot be forgotten that all observations are based on visual scoring only.

In order to reduce the amount of work, scoring can be done on a limited number of internodes only. The correlation between the average value for all internodes of a branch and of internodes 1, 3, 5, etc., from top proved to be +0.997 and the correlation between the former and the average readings on internodes 1, 5, 9, etc., + 0.987.

Water Relations

(a) Measurements on the elongation of branches and the speed of appearance of new nodes were made in the Irrigation Trial in order to study the formation of bearing wood as a function of irrigation treatments.

This trial is laid out as a 2 × 2 × 2 factorial experiment and the plots are sub-divided for

(1) method of application (overhead v ground irrigation) and

(2) plus or minus nitrogen fertilization.

The main treatments are:

(a) Irrigation towards the end of the Short Rains flood-flow period (December to early January).

(b) Irrigation towards the end of the Long Rains flood-flow period (May to early June).

(c) Irrigation during August (a "crop-saver").

An extra treatment designated X is incorporated in the trial by which irrigation is applied whenever the soil moisture deficit is estimated to be greater than two inches.

Analysis of the results over a full year shows that the X-treatment had a significant effect on branch elongation as compared with treatments a, b, c and (1), at 5% level, and not in comparison with treatments ab, ac, bc and abc. Treatments X and c increased the length of the internodes. Differences are mainly produced in the dry season between the Short and the Long Rains.

No direct correlation can be seen between measurements of branch elongation, as carried out in this study, and growth in terms of accumulation of total dry weight, especially as most of the latter is accumulated in the berries. Furthermore, irrigation not only acts on growth by removing or reducing soil moisture tension but equally interferes with the cropping cycle by its influence on flowering. Thus, in treatment c flowering was delayed by the end of 1960. In these trees, the stress of the growing crop was felt somewhat later than in the others and this offers an explanation for the more vigorous growth of the former trees, early in 1961. On the other hand, the crop of the treatment c trees came off later and, consequently, in mid-1961 they did not grow as vigorously as the trees from which the crop had been picked.

Fig. 6 gives the branch elongation in treatments (1) and X as well as the average of all nine treatments. After August 1961, trees of treatment (1) show a more vigorous flush of growth than trees of the X-treatment, as a result of the later picking in the latter.

Observations on stomatal aperture were continued throughout 1961, in treatments a, b, c, (1) and X, ground and overhead irrigation, plus or minus nitrogen fertilization. The differences in aperture between +N and —N treatments, reported already in the preceding year, were more pronounced in treatment X than in treatment (1) but disappeared gradually towards the end of 1961, possibly under the influence of the continuous rains.

Even in the X-treatment, where soil water is ample, variation in stomatal aperture proved to be considerable. According to Heath and Orchard (*Nature* **180**, 1957, 180) the explanation must be found in temperature differences. All observations were done in the afternoon; for the X-treatment between 2 p.m. and 2.30 p.m. (local standard time). The correlation between stomatal aperture and temperature measured *in situ* was calculated to be —0.964 for the X, + Nitrogen treatment (see Fig. 7), and —0.830 for treatment X, —Nitrogen. The correlation between stomatal aperture and temperature as measured at 3 p.m. at the meteorological observation post was — 0.832, and between stomatal aperture and relative humidity + 0.720. Obviously, also temperature and relative humidity are correlated (r = 0.817).

It is difficult to study the relation between stomatal aperture and soil moisture in the other treatments as the amount of soil moisture varies within wide limits. An effort was nevertheless made in treatment (1) for the period between mid-July and mid-October 1961, when total soil moisture did not change appreciably. The correlations found between stomatal aperture and temperature were —0.846 for the (1) + Nitrogen treatment (see Fig. 7), and —0.813 for the (1) —Nitrogen treatment. From Fig. 7 it can also be seen that the temperature coefficient is higher in the (1)- than in the X-treatment, but the difference is not significant. It will be appreciated that the line for the (1) treatment

Fig. 6 Elongation of branches in the Irrigation Trial

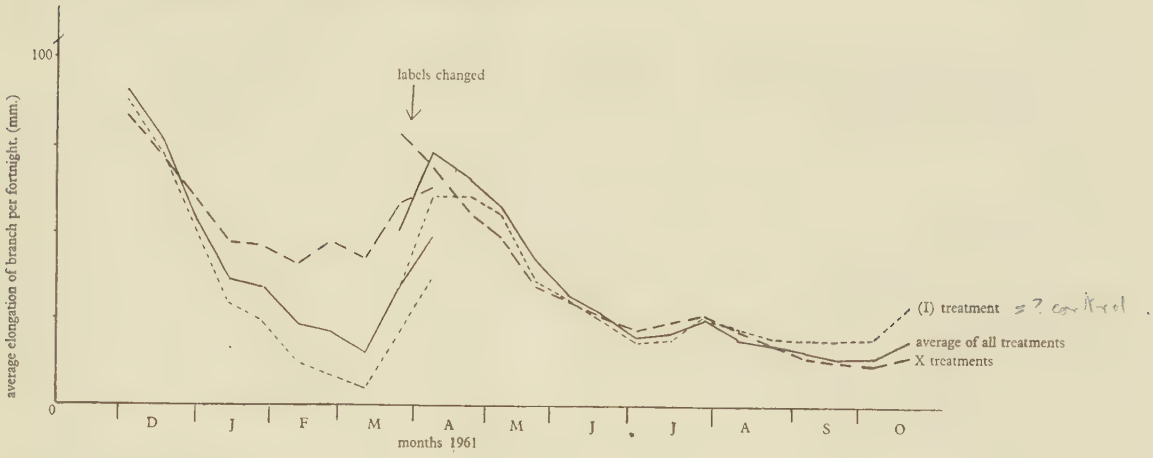


Fig. 7 Stomatal aperture as a function of temperature in coffee trees in wet and also in rather dry soil

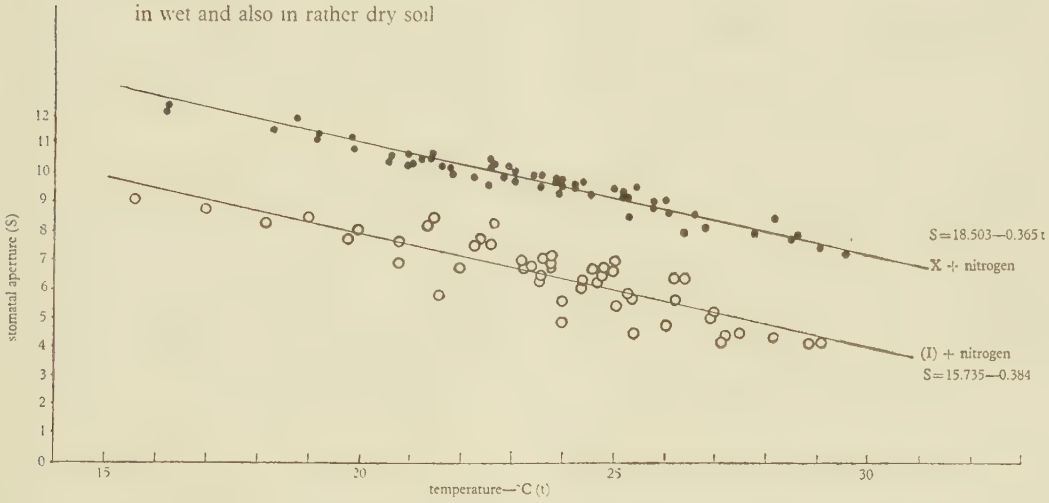


Fig. 8 Stomatal aperture in the Irrigation Trial [treatments a, b, c, and (I)] as percentage of aperture reached in a fully wet soil

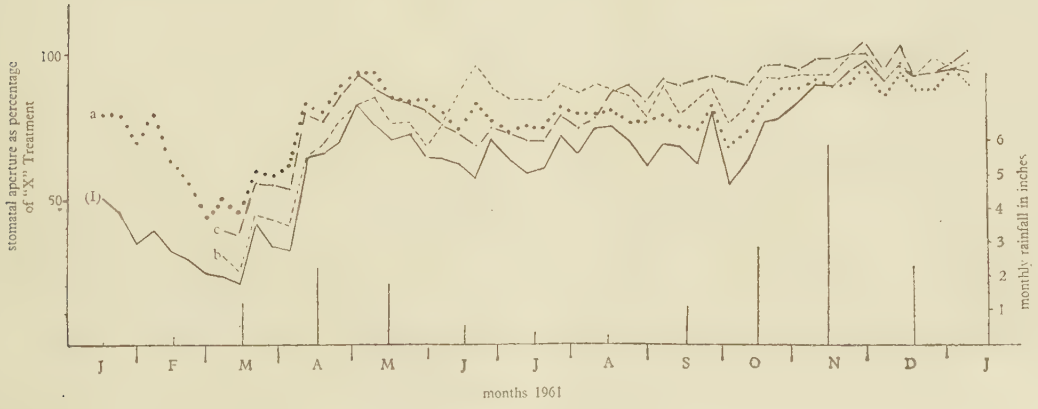


Fig. 9 a, b, c, d Stomatal aperture (as percentage of treatment X) and soil moisture deficit

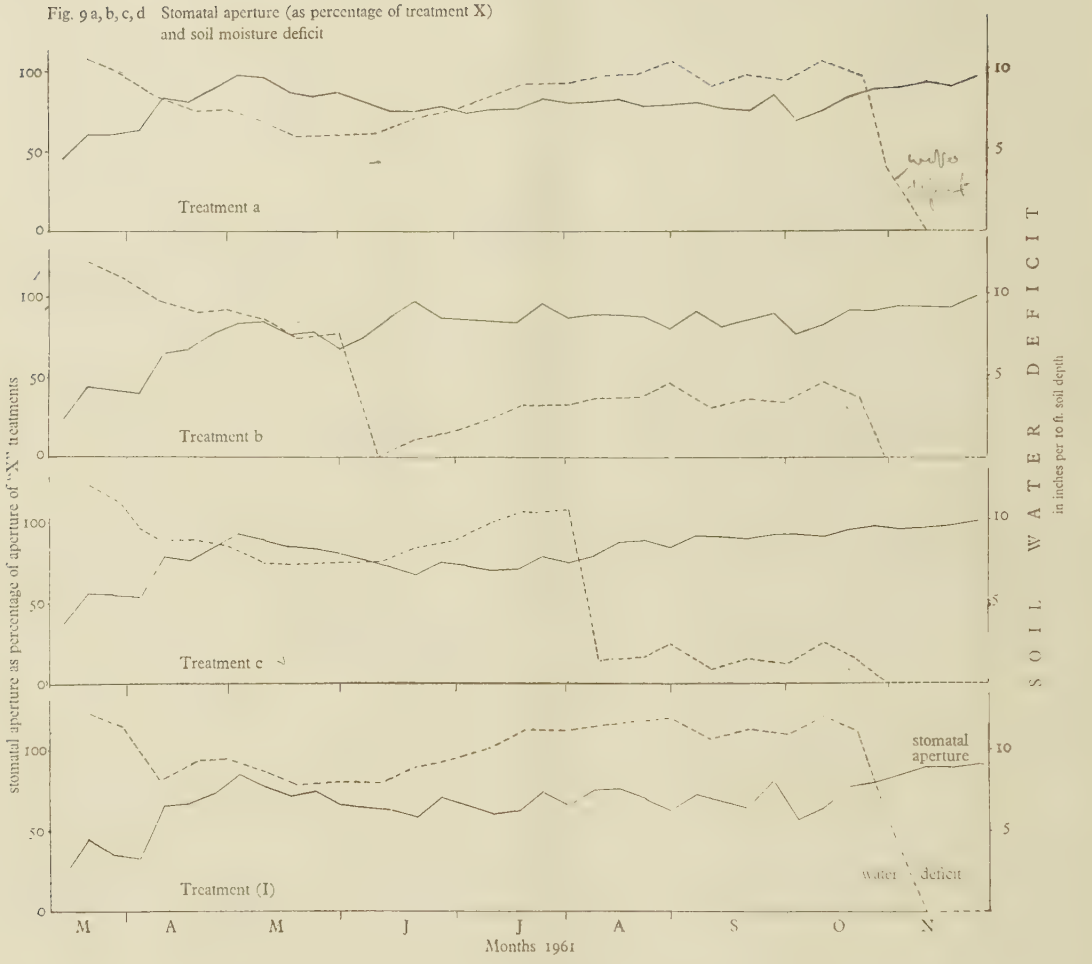
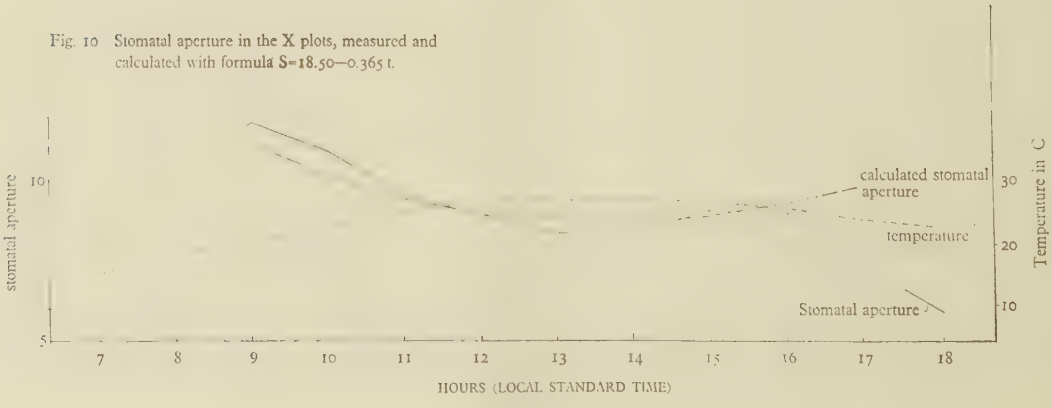


Fig. 10 Stomatal aperture in the X plots, measured and calculated with formula S=18.50—0.365 t.



is not typical for this treatment as a whole but is only valid under the specific conditions of soil moisture then obtaining.

In Fig. 8, width of stomatal aperture is presented as the percentage of the aperture in treatment X, in order to reduce variability due to differences in temperature. It is not certain that the lesser aperture is the maximum which the other treatments could reach as there are indications that stomata laid down in dry conditions never attain the width of opening reached by those originating in wet weather. Values for February, 1961, are too high as by that time the X plots had developed an appreciable water deficit which could be detected in the width of the stomatal aperture.

At every given date, placing the treatments in order of decreasing width of stomatal aperture gives the same result as testing them according to increasing (calculated) soil moisture deficit. There is, however, no linear relation between width of stomatal aperture and soil water deficit, as can be seen in Fig. 9. Though such a relation can satisfactorily be found when the soil is drying (January–March), it can no longer be maintained when the rains bring moisture to parts of the soil profile. With such rains, the trees are extracting water mainly from these wet horizons and, consequently, total soil water deficit is not a very satisfactory way of expressing the water stress to which the plant is submitted.

A few curves were constructed representing the daily movement of stomatal aperture. In the X plots, binomial curves are the normal picture. Stomatal aperture in the afternoon varies, as proven above, mainly under the influence of temperature. In the morning, width of aperture is always somewhat higher than would happen if the equation of the regression line of Fig. 7 applied. After approximately 4.30 p.m. width of stomatal aperture is very much reduced even though the temperature drops (see Fig. 10). This cannot be an effect of light intensity as it happens on dull as well as on bright days. Obviously, width of stomatal aperture is also related to the hour of the day.

Crinkle Leaf

In a variety trial at Chemoge (Elgon Nyanza), visual scoring assessing the severity of symptoms of the Crinkle Leaf condition was done for a period of two years on 12 varieties of coffee trees. The following order was found (ranging from minimum to maximum susceptibility):

1. Ke 20; 2. Gheisha; 3. Dilla; 4. Kenya Selected; 5. Dilla and Alghe; 6. Kents; 7. Blue Mountain; 8. Padang; 9. Dalle; 10. SL 34; 11. Kapretwa Series A; 12. K 7.

However, differences were significant only between K 7 and Ke 20, Gheisha, Dilla and Kenya Selected, and between Kapretwa Series A and Ke 20.

Spray trials with Captan continued but no final conclusion can yet be stated.

PLANT PATHOLOGY

Leaf Rust

Low Volume Spraying

The main work on Leaf Rust has been a series of field trials and investigations designed to determine if the disease could be controlled using volumes of spray lower than those currently recommended. Current recommendations involve the use of 7 lb. of a 50 % copper fungicide in 60–80 gallons of water. Using motorised knapsack mistblowers and tractor-mounted air-assisted sprayers, the control of Leaf Rust achieved by a wide range of volumes and concentrations of fungicide has been investigated. The amount of copper deposited on the leaf surface has been studied in relation to the volumes and concentrations. Some of the copper determinations were carried out by the Tropical Pesticides Research Institute, Arusha, Tanganyika, but recently these have been carried out by the Pathology Laboratory. Very detailed records have been made on this series of trials and the routine recording of Leaf Rust and Leaf Fall together with the copper determinations has fully occupied the laboratory staff for most of the year. Over 10,000 leaves per week have been counted and examined for number of rust lesions and more than 300 copper deposits have been determined colorimetrically. In the course of the trials, the use of dyes, fluorescent tracers and rubeanic acid prints for the assessment of spray distribution on foliage has also been investigated.

The preliminary trial, reported last year, established that where spray was applied individually to each tree using a knapsack mistblower (KWH Type 75 "Kiekens Whirlwind" Mistblower) satisfactory disease control could be achieved with 4 gm. of fungicide in 50 ml. of spray fluid per tree. Subsequent yield records have shown that this treatment raised the yield of clean coffee by over 5 cwt. per acre and that there was no significant difference in yield between the high- and low-volume spray treatments. The high-volume spray contained three times the weight of fungicide in sixteen times the volume of water, as compared with the low-volume treatment.

A further trial, using a "Holder" Mistblower, comprised treatment combinations giving the following range of comparisons:—

Spray volume 125 - 500 ml. per tree

Fungicide 2.5 - 50.0 gm. per tree

Spray concentration 1.25 – 40.00% W/W.

This trial confirmed that it was possible to control Leaf Rust successfully using low volume of spray applied by knapsack mistblower, and it was concluded that, in practice, such a machine could be used at approximately 10 gallons per acre (depending on spacing of trees). At this volume, 6 lb. of a 50% copper fungicide per acre was required to give adequate disease control. This quantity, however, is based on trials where only one spray application was made. Since it is usual, at least in the Long Rains, to apply further supplementary sprays, the possibility of reducing the amount of fungicide in each application is now being investigated.

Following the success of the trials with knapsack sprayers, the work was extended to the use of tractor-mounted air-assisted sprayers. Three trials were carried out, in which a range of treatments was applied to large plots of one-third to half an acre each. The sprayers used were the "Chiron LM 2/200" and the "R.S.M. (10 spout)." In the first trial, there was found to be no difference in the Leaf Rust control achieved using 8 or 50 gallons of spray per acre. A second trial confirmed this result, and various mechanical considerations led to the conclusion that with the sprayers available the most practical volume would be about 20 gallons per acre. A further trial was initiated to determine the optimum rate of fungicide to be used in this volume and it was again found that, using a single pre-rains spray, at least 6 lb. of 50% copper fungicide per acre was necessary.

The determinations of copper deposits made during this series of trials indicated that an overall copper deposit of 60 mg. Cu. /m^2 leaf surface was sufficient for disease control. The variability of the spray deposit, however, was very high and if it could be reduced it is probable that a lower mean copper deposit would suffice. In order to obtain detailed information on this subject, more extensive leaf

sampling is required than has been possible with the copper determination techniques used. A full account of these trials has been prepared for publication.

Mist Dusting

Three experiments in Kisii during 1960 and 1961 showed that a mist dusting treatment, using Cuprol 16 Dust applied with an A.S.I. knapsack mist duster was ineffective for Rust Control.

Rust Race Screening

Various rust collections were screened during the year. The only record of particular interest was Race I on *Coffea excelsa* from Embu.

Soil Fumigation

The soil fumigation experiment, using D-D in the Coffee Research Station nursery, has now been completed. Seedlings were examined in detail when they were 18 months old, and the root systems were carefully washed out. Seedlings from the fumigated beds showed a twofold increase in dry weight and total leaf area, and a threefold increase in the length of the tap root. There was a very marked difference in the appearance of the root systems and the stubby, much-branched root system, typical of the plants from unfumigated beds, was replaced by a much more extensive system of finer and less branched roots. Despite the obvious efficiency of this root system in producing very much improved aerial growth, it poses a problem in transplanting into the field because a large proportion of it is lost during removal from the nursery.

The cause of the fumigation effect in nurseries remains unknown, but from the practical point of view it promises to overcome the problem of seedling decline in nurseries under continuous use. The fact that Aldrin also has a marked stimulation effect on growth of seedlings suggests that at least part of the D-D effect may be by virtue of its insecticidal properties. In collaboration with Dr. Hollis of Scott Agricultural Laboratory, the nematode populations of coffee nurseries have been investigated. In no case have significant numbers of plant parasitic nematodes been detected. A new species of *Pungentus* has been found to be in constant association with the stubby root symptoms, but observations on excised root systems in the laboratory have not shown this nematode to feed on living roots.

Stem Pitting

A full account of the symptoms and incidence of this condition has been accepted for publication in *Tropical Agriculture*. Numerous sections have been examined from experimental plants which have been used to investigate possible insect transmission of the condition. No positive results have yet been obtained.

Elgon Dieback

An experiment was laid down in the Trans Nzoia during 1961 to determine whether Elgon Dieback could be controlled with high-volume copper sprays. On the basis of the recent implication of *Colletotrichum* as a cause of the disease, one of the treatments was the recommended schedule for the control of Coffee Berry Disease (i.e., four sprays at fortnightly intervals commencing mid-February, with further sprays in June and July).

The full range of treatments were:—

1. Control. No spray.
2. Spraying after hail storm only.
3. C.B.D. schedule sprays.
4. C.B.D. schedule + post-hail sprays.
5. Monthly sprays.
6. Monthly + post-hail sprays.

All sprays were applied at the rate of 14 lb. of a 50% copper fungicide in 200 gallons of water per acre. The post-hail sprays were designed to give immediate protection within 24 hours of a hail storm to try to estimate the importance of hail as a cause of severe outbreaks of the disease. In the event, no hail

storms were recorded, so this treatment was not applied. The total number of Elgon Dieback infections per tree was recorded every month from May onwards. The results are briefly summarised in the Table

Treatment	*No. of EDB infections per tree occurring between January and May*	*No. of EDB infections per tree occurring between May and October*	*Total*
Control	14	14	28
Monthly	2	9	11
C.B.D.	3	9	12

Both monthly and C.B.D. schedule sprays significantly reduced ($p=0.001$) the total number of infections, but it will be noticed that after May neither of these treatments had any further pronounced effect. Although the C.B.D. schedule sprays helped to alleviate Elgon Dieback, the level of control achieved on this trial cannot be said to be satisfactory.

In another trial in Elgon Nyanza, a similar set of treatments was applied. Monthly, C.B.D. schedule, and post-hail sprays all slightly, but not significantly, reduced the incidence of Elgon Dieback.

Records of Fungi

Two Myxomycetes have been recorded on coffee leaves. *Physarum melleum* Mass. on *Coffea robusta* in propagating frames at the Coffee Research Station, and *Physarum vernum* Somm. on *Coffea arabica* in a nursery at Thika where the leaves and stems of several seedlings became covered with the organism.

ENTOMOLOGY

General Pest Situation

The year has been remarkable for the small amount of damage done to coffee by insect pests. The widespread outbreaks of Leaf Miner which usually occur in the latter months of the year did not materialise in 1961. This appeared to be largely due to the torrential Short Rains. Antestia caused only local damage in the East Rift areas. In the Kisii highlands overall populations have dropped considerably since 1959. Capsid Bug numbers were very high at the beginning of 1961 due to a succession of small flowerings but little damage of economic importance occurred. Leaf-eating caterpillars were not much in evidence in the East Rift but in the West Rift Leaf Skeletonizer and Tailed Caterpillar outbreaks were common.

Research Programme

Most of the research effort was concentrated on Leaf Miner. As reported below, progress was made on chemical control and population studies. It was not, however, possible to begin studies of the third main facet of the Leaf Miner problem, the actual loss of yield due to this pest.

Below are given the results of work during 1961/62 under individual pest headings.

Root Mealybug *Planococcus citri* Risso

Many infills on a Ruiru estate were attacked by Root Mealybug. The control measures devised in Uganda for another species of root mealybug *Pseudococcus latipes* were tried. Trees showing a range of symptoms from slightly wilted green leaves to dead brown leaves were selected. 2 oz. of 2½% aldrin dust was mixed with the soil under each tree, especially round the collar. A generous layer of mulch was then put down and the trees were irrigated until the rains began. Trees with green or yellow leaves appear to have recovered completely. Trees with brown leaves have died even though the bark of the main stem was healthy at the time of treatment.

White Waxy Scale *Ceroplastes brevicauda* Hall

An article on the biology and control of White Waxy Scale was published in the March 1962 number of *Kenya Coffee*.

Star Scale *Asterolecanium coffeæ* Newst.

An article on the biology and control of Star Scale was published in the January 1962 number of *Kenya Coffee*.

Bark Scale *Lecaniodiaspis erratica* De Lotto

About 30 acres of a Kiambu estate were badly attacked by *L. erratica*. The damage caused by this species is similar to that caused by *Asterolecanium*. The vertical stems grow thin and whippy and there are many breakages. No treatment was applied to this infestation and it gradually subsided due to natural causes.

Lace Bug *Habrochila ghesqueirei* Schout.

Preliminary laboratory trials were carried out to determine the ovicidal properties of a series of insecticides against the eggs of Lace Bug. It was found that diazinon and pyrethrum at normal field concentration gave no kill of eggs laid in leaves when those leaves were dipped for one second in the insecticide mixture. Malathion gave only a small kill while a methyl-parathion emulsion and a parathion suspension gave moderate to good control. Parathion emulsions killed a very high percentage of eggs at concentrations as low as 0.006% a.i. Further laboratory tests showed that parathion emulsions applied to the upper surface of a leaf gave only a moderate kill of eggs embedded in the lower surface.

Antestia Bug *Antestiopsis lineaticollis* (Stal)

A successful technique for laboratory breeding of Antestia Bugs has been developed and large numbers are now available for experiments. Scrupulous cleanliness is essential to keep down mortality in the early instars. Glass, cloth and metal components of the cage are autoclaved before use. Other components are dipped in 0.1% thymol. Fourth and fifth instar nymphs are used for field and laboratory trials.

Work has continued on low-volume pyrethrum sprays. When the trees have been recently pruned and are carrying very little crop, low-volume sprays give a satisfactory knock-down. When the cherry clusters are nearly full-grown however results have been less satisfactory. These experiments are continuing.

Thrips *Diarthrothrips coffeæ* Will.

Thrips counts during January and February 1962 were the lowest recorded for these months since regular counting was instituted in 1955. The most likely explanation of this is that the torrential Short Rains made soil conditions unsuitable for the pupal stages of *D. coffeæ* during the last months of 1961.

Leaf Miners *Leucoptera meyricki* Ghes. and *L. caffeina* Washb.

Dr. Bess (Fulbright Scholar) completed his study of the integration of biological and chemical control of Leaf Miner in June 1961.

His main conclusions were:

(i) that the insecticides currently used for Leaf Miner control (parathion, methyl-parathion and diazinon) do not adversely affect the host/parasite ratio.

(ii) that the correct timing of sprays is of prime importance if a worthwhile degree of control is to be achieved.

He is now writing up his work in detail and it will probably appear in print in 1963.

A bioassay technique using *L. meyricki* as the test insect has been successfully evolved. Adult moths are caged on trees in the field for oviposition. Leaves bearing eggs are picked when the eggs are on the point of hatching. These leaves are kept at high humidity and constant temperature until the larvæ have reached the third instar. The leaves are then sprayed in a Potter tower and kept for three days in an air stream at high humidity. The mines are then dissected and living and dead larvæ are counted.

Using these techniques the following results have been obtained:

(i) Sixteen insecticides have been screened and rejected as possible alternatives to parathion and diazinon. These are azinphos-methyl (Gusathion), Chlorthion, dichlorvos (DDVP), dimethoate (Rogor 40), Eradex, Isochlorthion, malathion, menazon (P.P. 175), Metasystox "i", methyl-demeton (Metasystox), phenkapton, phosphamidon, pyrethrum, Thiodan, toxaphene and trichlorphon (Dipterex).

(ii) Delnav and mevinphos (Phosdrin) have been screened and showed little promise. They will however be screened again as new formulations have become available.

(iii) Dibrom, Lebaycid, fenchlorphos (Nankor) and S.D. 3562 showed sufficient promise in the laboratory screening to warrant field trials.

(iv) Parathion and diazinon are absorbed into the leaf lamina and act mainly as stomach poisons. They are equally effective whether applied to the upper or lower side of the leaf.

(v) Sprays made up from emulsifiable concentrate formulations are more effective than those containing an equal quantity of insecticide made up from wettable powder formulations.

(vi) The addition of extra wetters improves the performance of most of the commercial formulations available in East Africa.

(vii) At laboratory temperatures *L. caffeina* is killed by lower concentrations of parathion than *L. meyricki.*

Many of these points require checking in field trials before revised recommendations can be issued for the control of Leaf Miner.

Technical parathion, methyl-parathion and diazinon have been formulated in the laboratory and dosage/mortality curves have been determined for *L. meyricki* under controlled conditions. It will now be possible to detect the development of resistance by *L. meyricki* to these insecticides at an early stage should it occur.

A study of the population dynamics of *L. meyricki* was begun in August 1961. Weekly counts of moths, eggs and adult Leaf Miner parasites are made on marked trees. It has been established that even at low densities the generations of Leaf Miner are well defined. For each generation an assessment is made of percentage mortality in the egg, larval and pupal stages. These field counts are being supplemented by laboratory studies of the principal parasites. It is hoped that this work will throw light on the cause of Leaf Miner outbreaks. Present indications are that an outbreak generation is marked by an increased rate of egg-laying rather than a decline in the population of parasites.

Stinging Caterpillar *Parasa vivida* Walk.

A study of the life history of *P. vivida* was begun during the year. In some generations there is a prolonged prepupal diapause which in Kenya has lasted as long as 126 days. This diapause had earlier been reported from Nyasaland (Smee, C., *Nyasaland Tea Ass. quart. J.* **3,** 1–8). On a small plantation it should be possible to prevent an outbreak by destruction of the conspicuous cocoons.

Adult *Parasa* have been collected both east and west of the Rift Valley but damage to coffee by the caterpillars is only recorded from areas East of the Rift.

Looper Caterpillars *Ascotis reciprocaria* Wlk. and *Epigynopteryx coffeæ* Prout.

Outbreaks of Brown Looper *A. reciprocaria* occurred in Kiambu, Ruiru and Mitubiri districts. This pest appears to have come into prominence because it is not killed by parathion or methyl-parathion at the rates recommended for Leaf Miner control. Presumably, however, some or all of its natural enemies are killed by these insecticides.

Small field trials confirmed that the following insecticide applied as high-volume sprays gave a negligible kill after four days: malathion (0.25% a.i.); aldrin (0.05% a.i.) and lead arsenate (0.25% a.i.). However DDT (0.1% a.i.) and the pyrethrum /DDT treatment developed for Antestia control were highly effective.

The main features of the life history were worked out in the laboratory. At 68.5°F the following development periods were recorded: egg, 8–9 days; larva, 25-35 days; pre-pupa, 4 days; pupa, 12–14 days. A number of Tachinid and Hymenopteran parasites were collected but have not yet been identified.

The Green Looper *E. coffeæ* has also caused much damage on shaded coffee in Upper Kiambu. There are unconfirmed reports that this species also is not killed by parathion.

White Borer *Anthores leuconotus* Pasc.

Borers collected from altitudes up to 6,000 feet above sea level in the Mbooni Hills, Machakos District, have been identified by the British Museum specialist as *A. leuconotus*. There is no previous record of White Borer in Kenya occurring at altitudes much above 5,000 feet.

Yellow-Headed Borer *Dirphya nigricornis* Ol.

An article on the Yellow-Headed Borer has been accepted for publication in the *Journal of the Entomological Society of Southern Africa.*

Ant Control *Pheidole punctulata* Mayr.

Experiments are in progress to test two methods of ant control in newly transplanted coffee. During their first one to two years in the field the stems of coffee trees are too small to apply the 1% dieldrin band which is so effective in controlling the coccid-attending *P. punctulata* on mature coffee. Tests are being made of:

(i) overall dieldrin sprays on the soil.

(ii) dusting the stems with 0.5% dieldrin applied with a small hessian bag.

Inverted honey pots are fixed in the trees so that it is immediately obvious when the treatment is no longer effective even if there is no mealybug or scale infestation. Both treatments show promise of being useful in certain circumstances.

Rust Spore Vectors

Recent work by Nutman, Roberts and Bock in Kenya has shown that the spores of leaf rust *Hemileia vastatrix* are very largely dispersed by rain splash, not by wind, This finding has clarified much that was inexplicable in the epidemiology of the disease but makes it difficult to see how new plantings remote from other coffee receive their initial *Hemileia* inoculum. Field and laboratory observations suggest that two species of parasitic Hymenoptera *Leptacis kivuensis* Risbec and a *Synopeas* sp. play a part in the long-range distribution of the disease. The adult parasites become heavily contaminated with uredospores when searching in rust pustules for their hosts. The host insects are the larvæ of two species of Cecidomyid midge which feed on rust spores. This work has been written up for publication.

Wood Lice

Seedlings in the nurseries of two Ruiru estates were attacked by a species of woodlouse, as yet unidentified. Damage consisted of chewing out small pieces of the root cortex. Large numbers of small seedlings were killed. Both the affected nurseries were unmulched.

It appeared probable that mulching would be sufficient to control this pest since rotting dead leaves are a more attractive food than living coffee roots. A sevin/metaldehyde bait has been reported to give good control of woodlice in South Africa (Theron, J. G, *J. ent. Soc. S. Afr.* **24,** 220–221), but it has not yet proved possible to test it in coffee nurseries.

COFFEE PROCESSING RESEARCH

Recirculation of Water

With the heavy drought in the early part of the year experiments were undertaken to find the effect, if any, on quality, of recirculating factory effluents. A set of experiments on early crop were conducted at Matungulu Estate, main and late crops being tested at Rukera Demonstration Farm and with coffee and effluent at Njuno Estate, Upper Kiambu.

Stage of Ripeness

Following Dr. Wormer's investigations into the annual build-up and usage of starch in the coffee plant, experiments have been conducted to find at what stage in the beans' development "quality" reaches its highest level. Beans in all stages from hard green to mbuni have been tested and subjected to different methods of fermentation and chemical cleaning.

Fermentation

All experimental work involving fermentation has been linked to tests to assess the value of fermentation in the production of "quality". As the normal fermentation period is that part of the process during which the greatest risks are run of picking up ill flavours, it is hoped in these experiments to find if fermentation as such can be replaced by chemical or mechanical cleaning without loss of quality.

"Softs" in the Roast

Preliminary investigations have been made to discover the source of "softs" in roast coffee. Experiments indicate that faulty processing plays a considerable part in the production of this type of roast.

Coffee Pumps

A selection of pumps for handling coffee has been tested by Dr. Ghosh of the East African Industrial Research Organisation.

Grading of Coffee

Dr. Ghosh also carried out work to find the benefit, if any, of grading coffee in the washing channel. Investigations into the physical properties of different grades show no benefit but before final recommendations are made work is continuing to find any possible difference in the quality of the different grades.

Onion Flavour

Mr. Wootton, Senior Scientific Officer, and his staff of the East African Industrial Research Organisation have continued their efforts to eradicate "Onion flavour" in Kenya coffees.

The Coffee Processing Sub-Committee met on two occasions under the Chairmanship of the Senior Research Officer.

COFFEE GROWING IN AFRICAN AREAS

Despite the very adverse climatic conditions during 1961, the total coffee crop produced in African coffee-growing areas rose slightly from 7,769 tons in 1960/61 to 7,955 tons in 1961/62. Most of the early crop was affected by drought conditions but some excellent quality coffee was produced in the Mount Kenya Coffee Areas during November and December. The quality of some coffee produced in Nyeri District was outstanding while the Meru and Embu districts again obtained excellent results; over 1,800 tons of coffee from these districts was classified in the first three classes.

The Southern Province coffee areas were badly hit by the drought but high standards of cultivation and good factory work resulted in the production of some excellent quality coffee from the Kangundo and Matungulu areas. At the Royal Show in September the Matungulu Society won the open class for a commercial out-turn of coffee.

In Nyanza Province the Kisii and South Nyanza districts produced a combined coffee crop in excess of 1,000 tons for the first time. Unfortunately the quality of this crop was poor, only 0.37% being classified in the first three classes. Strenuous efforts are now being made to improve the standards of management in coffee factories. Drying facilities are inadequate at many coffee factories, more drying tables and drying trays are urgently required if better results are to be obtained in the next crop season.

Coffee Production

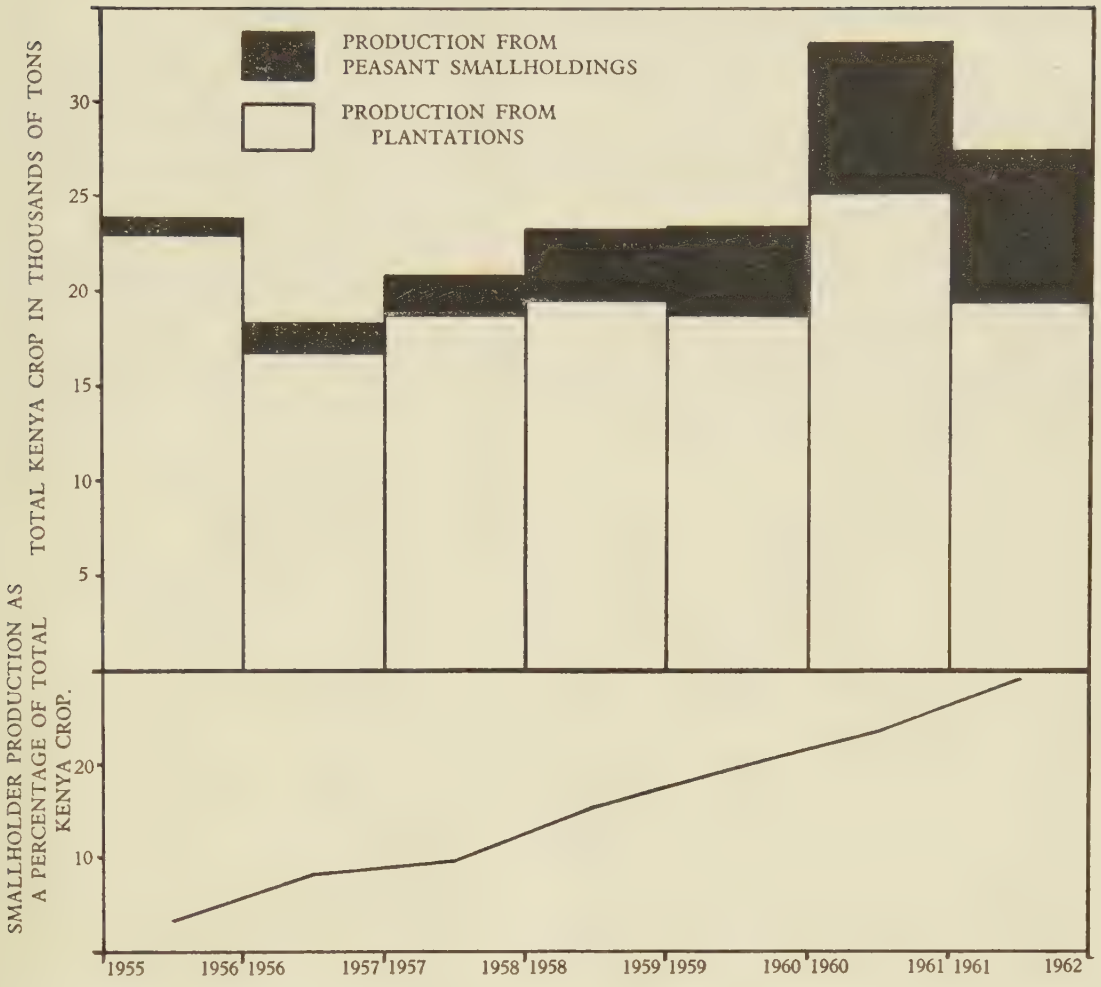
Figure 11 shows the increasing importance of coffee production in the African Areas. During the next five years the total amount of crop produced in African Areas will increase rapidly, especially as many thousands of acres of new coffee has been planted in areas where coffee is known to thrive. In Central Province approximately 10,400 acres of coffee was planted in 1961; this should result in the production of an extra 5,000 tons of coffee by 1965. The level of cropping remains high in many districts, Embu district produced about 12 cwt. of clean coffee from each acre of fully bearing coffee during the 1960/61 crop season.

All advisory and extension officers in African coffee areas have continually emphasised the need to maintain and if possible to improve upon the existing standards of cultivation and factory work. Every opportunity was taken at conferences and courses to inform coffee farmers that world coffee production is now greatly in excess of world coffee consumption. Many Societies are now convinced that the future prosperity of coffee growers will only be assured if growers continue to produce good-quality coffee for processing at factories.

Coffee continues to be an extremely attractive cash crop for the small peasant farmer. In the best coffee-growing areas an average cash return per tree of about Shs. 8/- is still common whilst in the very best areas and on the outstanding farms, cash incomes per tree of between Shs. 10/- and Shs. 12/- are not unknown.

Payments on an individual factory basis as distinct from a Society basis were introduced in some districts during 1961. With the increased production of coffee in lower areas it is very important to encourage differential payments in Societies with two or more factories. During the year definite evidence was obtained from several Provinces to show that coffee produced at lower altitudes was usually of inferior quality. In some districts coffee societies have both high- and low-altitude factories. If payment to coffee growers is not made on an individual factory basis, this usually results in the coffee growers in the higher altitude areas subsidising coffee growers who deliver coffee cherry to factories situated in the lower altitude areas. At the present time it is essential that the system of payment to growers should stimulate the production of high-quality coffee; this can only be achieved when payments are made on a per factory basis.

Fig. 11 KENYA COFFEE PRODUCTION



Courses and Extension Work

An increased number of courses were held at the Coffee Research Station. Three Senior Agricultural Department Courses each of a week's duration were attended by Agricultural Officers and Assistant Agricultural Officers working in the various African coffee areas. Courses were also held for Agricultural Instructors and numerous parties of African coffee growers visited the Coffee Research Station during the year.

The Kenya Broadcasting Service transmitted a monthly Coffee Discussion programme in Swahili on the African National Service. These programmes are in the Better Cash Crops Farming Series; advice and information of topical interest on coffee matters is the main aim of these Broadcasts. In January 1962 vernacular broadcasts on coffee growing were commenced in the Regional Service of the Kenya Broadcasting Service. Regular coffee discussions are now broadcast in Kikuyu, Kimeru and Kikamba.

Coffee Variety Trials in African Areas

The knowledge obtained from Coffee Variety Trials in African Areas during the past decade has enabled rapid and successful development of coffee growing in many districts. It is now possible to

recommend suitable coffee varieties for a very wide range of climatic and soil conditions. In some areas it is also possible to define geographically the economic limits for coffee cultivation.

In areas where Leaf Rust *Hemileia vastatrix* and Coffee Berry Disease *Colletotrichum coffeanum* are of no account the varieties SL 28 and SL 34 are planted extensively. Both varieties produce good crops of high-quality coffee. If the incidence of Leaf Rust or Coffee Berry Disease is serious, varieties with suitable disease resistance are chosen. The reason for this is that spraying in African Areas, where topography is often precipitous, is frequently difficult to organise. The variety Blue Mountain is recommended where a Coffee Berry Disease resistant variety is necessary.

Where Leaf Rust is usually endemic, the varieties SL 6 and K 7 are recommended, because these varieties have been outstanding where only Race II of Leaf Rust occurs. Unfortunately in certain areas Race I is often endemic. The Indian S and BA series are known to be immune to both Races of Leaf Rust, but the performance of these varieties in Variety Trials has been disappointing. Considerable variation occurs within each variety and crops are usually only moderate to poor; liquoring tests have revealed that S and BA varieties usually produce liquors of inferior quality when compared with SL 28 and SL 34. Attempts are being made to select individual trees with improved cropping and liquoring qualities from these varieties.

RUKERA DEMONSTRATION FARM

Development

The replanting programme was continued during the year. A total of 6.06 acres was planted on the contour at a spacing of 10 feet × 8 feet. This acreage of SL 34 covered Plot 7 and extensions to Plots 12 and 15 respectively. The Soil Conservation Service carried out detailed planning and constructed new roads, terraces and drainage ways.

The steeper slopes of Plot 7 which were unsuitable for coffee were planted to Napier Grass in rows 7 ft. 6 in. apart on the contour.

The Coffee Factory was modified to deal with the separation of coffee pulp and water, and the recirculation of water from the prewashing and final washing channels. This necessitated the installation of two centrifugal electric water pumps.

Four coffee conditioning bins were installed in the coffee store which was enlarged to make additional space.

1961/62 Crop

Rainfall 1.1.61 to 31.12.61 (inches)	56.54
Acreage in Production	63.06
Clean Coffee (tons)	18.76
Average per acre (cwt.)	5.94
Mbuni (lb.	2,543

Classifications	*lb.*	*Percentage*
Class 2	50	.13
Class 3	847	2.26
Class 4	3,125	8.48
Class 5	3,929	10.49
Class 6	8,289	22.13
Class 7	989	2.64
Class 8	1,214	3.24
Class 9	7,632	20.34
Class 10	4,788	12.79
Class 11	6,501	17.36
Class 12	52	.14
	37,466	100.00

Average price per pound Shs. 2.41.

7,579 lb. of parchment were prepared as coffee seed from clonal blocks of SL 28, SL 34 and SL 14. A clean coffee allowance has been added to the total weight of crop shown above.

Other Enterprises

During the year 4,268 lb. of Washington Navel Oranges were picked from the two acres of trees realising an average price of 13 cents per lb. The first crop of Nartjies produced 594 lb. of fruit and realised an average price of 24 cents per lb.

The remaining area of the fruit station which has been administered by the Horticultural Station, Thika, has now reverted to Rukera and will be utilised for production of Macadamia nuts on a commercial basis.

A young pedigree Guernsey bull was purchased during the year to replace the original bull purchased in 1957. The dairy herd was culled by 20 cows and heifers during the year, and most of the original dairy stock have now been eliminated.

Farm Accounts: 1960/61 and 1961/62

As from 1st July, 1960, the accounting system has been changed so that the financial year ends on 31st March, and not 30th June as previously. Consequently it has been possible in this edition to review both the 1960/61 and the 1961/62 crop tables, together with a comparison table on Cost of

Production for the 1959/60 season. The Costings for the 1960/61 season are based on a 12 months period whereas the balance sheet is based on nine months only, i.e. 1st July, 1960, to 31st March, 1961. The net profit figure for 1960/61, shown under Cost of Production, has therefore been adjusted to a 12 months period for comparison purposes.

It will be noted that acreages in production are not constant. This is due to the replanting programme being carried out each year.

(1) *Sales*

In 1960/61 the estate produced 32.4 tons of clean coffee which yielded £10,008 or £313 per ton after deducting curing and selling charges. The average yield was 9.51 cwt. per acre from 75.24 acres (which includes a clean coffee allowance from seed production areas). Seed production plots of 9.73 acres yielded 12,710 lb. of seed to a gross value of £4,766.

1961/62 produced 16.72 tons of clean coffee, which yielded £4,814 or £287 per ton after deducting curing and selling charges. The average yield was 5.94 cwt. per acre from 63.06 acres (which includes a clean coffee allowance from the seed production areas). Seed production plots of 9.73 acres yielded 7,579 lb. of seed to a gross value of £2,841.

(2) *Cost of Production*

Table LXX shows the cost of production for the past three seasons, expressed as crop expenses per ton (the components of which are enumerated in Table LXXII), the coffee maintenance, overheads and depreciation.

The cost of production per ton for 1961/62 was higher than in the two previous years due mainly to a low yield. In addition a further rise in coffee maintenance, overheads and depreciation occurred.

The figures below show the variation in profit per acre over the last four years. The variation is due mainly to fluctuations in yield. The 1960/61 figures have been adjusted for the 12 months period.

1958/59 £ 5,235.5 from 87.4 acres or £ 59.9 per acre.
1959/60 £ 4,203.5 from 83.4 acres or £ 50.5 per acre.
1960/61 £ 8,308 from 72.24 acres or £ 115.0 per acre.
1961/62 £ 1,700 from 63.06 acres or £ 26.95 per acre.

(3) *Cost at Varying Levels of Production*

Table LXXI compares the cost at varying yield levels for the last two seasons. It will be noted that the management Bonus has been omitted from the Table, as this is difficult to assess at the varying levels.

(4) *Analysis of Crop Expenses and Coffee Maintenance Costs*

The breakdown of operation costs for the two seasons is shown in Table LXXII and LXXIII.

Crop expenses include all costs incurred in picking and processing the crop.

The comparison of figures for crop expenses in relation to tons of clean coffee indicates that a light crop costs more in proportion to process than a heavy one. Seed production costs were higher in 1961/62 owing to hand selection being more difficult.

Table LXXIV shows the breakdown of Napier Grass Expenses given in the preceding Coffee Maintenance Table. It should be noted that the total acreage of Napier Grass is 21.54 acres for 1960/61 and 25.45 acres for 1961/62, which provided mulch for 16.54 acres of coffee maintenance in 1960/61 and 11.75 acres in 1961/62. There is therefore a different divisor for unit acre cost in the two tables.

Table LXXV shows the cost of Napier Grass Development for the two years.

(5) *Analysis of Coffee Development*

Table LXXVI gives the cost of bringing one acre of coffee into production. This includes maintenance, overheads and depreciation costs. Preparation of land does not include bush clearing or breaking virgin land. Overheads and depreciation are averaged out from the total acreage of coffee on the estate over the last three years. Coffee was planted 10 feet × 8 feet and tree row mulching carried out each year. For the first cycle trees are brought up on a single-stem system with 20 primaries, and at a later date will be converted to multiple-stem.

TABLE LXX

Cost of Production

	1961/62 Acreage 63.06 Crop 18.76 Tons Yield per Acre 5.49 cwt.		*1960/61 Acreage 75.24 Crop 35.8 Tons Yield per Acre 9.51 cwt.*		*1959/60 Acreage 83.28 Crop 25.65 Tons Yield per Acre 6.16 cwt.*	
	Per Acre	*Per Ton*	*Per Acre*	*Per Ton*	*Per Acre*	*Per Ton*
(a) Crop Expenses . .	—	£ 51.29	—	£ 42.27	—	£ 53.73
(b) Management Bonus .	—	£ 2.62	—	£ 13.42	—	£ 7.37
(c) Coffee Maintenance .	£ 23.60	£ 79.34	£ 17.61	£ 37.01	£ 19.96	£ 64.82
Overheads . .	£ 40.80	£137.23	£ 36.49	£ 76.69	£ 38.97	£126.52
Depreciation . .	£ 13.49	£ 45.35	£ 13.34	£ 28.54	£ 8.82	£ 28.64
	£ 77 89	£ 315.83	£ 67.44	£197.93	£ 67.75	£281 08

TABLE LXXI

Cost at varying level of production

1961/62 Crop

Cost per ton

Yield per acre	*3 cwt.*	*4 cwt.*	*5 cwt.*	*6 cwt.*	*7 cwt.*	*8 cwt.*	*9 cwt.*	*10 cwt.*
Crop Expenses	£ 51.29	51.29	51.29	51.29	51.29	51.29	51.29	51.29
Maintenance	£ 157.09	117.81	94.25	78.54	67.32	58.90	52.36	47.12
Overheads	£ 271.71	203.78	163.02	135.79	116.39	101.88	90.56	81.51
Depreciation	£ 89.79	67.34	53.87	44.89	38.48	33.67	29.93	26.93
	£ 569 88	440 22	362.43	310 51	273.48	245 74	224 14	206 85

NOTE:—Management bonus omitted.

1960/61

Cost per ton

Yield per acre	*3 cwt.*	*4 cwt.*	*5 cwt.*	*6 cwt.*	*7 cwt.*	*8 cwt.*	*9 cwt.*	*10 cwt.*
Crop Expenses	£ 42.27	42.27	42.27	42.27	42.27	42.27	42.27	42.27
Maintenance	£ 117.32	89.99	70.39	58.66	50.28	43.97	39.11	35.19
Overheads	£ 243.10	182.33	145.86	121.55	104.17	91.15	81.03	72.93
Depreciation	£ 90.47	67.85	54.28	45.23	38.77	33.92	30.15	27.14
	£ 493.16	380 44	312 80	267.71	235 49	211.31	192 56	177.53

TABLE LXXII

	Crop Expenses, 1961/62 (18.76 tons clean coffee)		*Crop Expenses, 1960/61 (35.8 tons clean coffee)*	
	Total Shs.	*Cost per ton* Shs.	*Total* Shs.	*Cost per ton* Shs.
Picking Coffee	10,219.40	544.75	17,460.67	487.73
Stripping	269.28	14.36	1,210.85	33.82
Transport	203.42	10.84	279.41	7.80
Factory Expenses	2,524.38	134.55	4,384.39	122.47
Bags and Twine	21.50	1.15	1,542.43	43.08
Transport Mills	112.68	6.00	550.25	15.37
Upkeep Machinery	702.00	37.42	1,725.00	48.18
Upkeep Drying Lines	367.32	19.58	1,025.42	28.64
Supervision Wages	1,910.16	101.82	1,164.76	32.54
Water Factory	179.15	9.55	189.00	5.28
Seed Production	2,704.08	144.14	736.99	20.59
Sundry Expenses	30.66	1.64	—	—
Shs.	19,244 03	1,025 80	Shs. 30,269.17	845 50

TABLE LXXIII

	Coffee maintenance 1961/62 (63.06 Acres)		*Coffee maintenance, 1960/61 (75.24 Acres)*	
	Total Shs.	*Cost per acre* Shs.	*Total* Shs.	*Cost per acre* Shs.
Weeding/Cultivation	5,409.28	85.78	4,863.96	64.64
Couch Control	629.40	9.98	1,020.52	13.57
Pest Control	1,481.50	23.49	2,179.51	28.97
Anti Rust/Tonic Spray	6,948.81	110.19	7,169.19	95.28
Fertilizing	7,565.17	119.97	3,240.15	43.06
Pruning	3,576.23	56.72	2,578.64	34.27
Handling	1,232.16	19.54	1,790.73	23.80
Sundry Expenses	294.78	4.68	115.30	1.53
Napier Grass Expenses	2,633.40	41.78	3,545.51	47.12
Shs.	29,770 73	472.13	Shs. 26,503.51	352.24

TABLE LXXIV

	Napier Grass Expenses 1961/62 (25.45 acres)		*Napier Grass Expenses 1960/61 (21.45 acres)*	
	Total	*Cost per acre*	*Total*	*Cost per acre*
	Shs.	Shs.	Shs.	Shs.
Weeding/Cultivation	135.30	5.32	912.04	42.52
Fertilizing	786.32	30.90	87.66	4.08
Cutting	1,104.76	43.40	1,485.97	69.27
Couch Control	1,056 88	41.52	938.34	43.75
General	38 08	1.50	82.89	3.86
Transport	217.90	8.57	1,086.15	50.63
Spreading	4,319.08	169.70	2,836.86	132.26
Shs.	7,658 32	300 91	Shs. 7,429 91	346 37
	Total	*Cost per acre*	*Total*	*Cost per acre*
Acres Mulched:				
Coffee Maintenance	11.75 acs.		16 54 acs.	
Coffee Development	22.42 „		18.12 „	
	34 17 „ Shs.	224 12	34 66 „ Shs.	214 36

TABLE LXXV

	Napier Grass Development 1961/62 (7.5 acres)		*Napier Grass Development 1960/61 (8.3 acres)*	
	Total	*Cost per acre*	*Total*	*Cost per acre*
	Shs.	Shs.	Shs.	Shs.
Land Preparation . .	75.58	10.08	342.44	41.25
Planting . . .	1,802.54	240.34	2,256.79	271.90
Fertilizing/F.Y.M. .	2,614.57	348 61	1,936.50	233.31
Cultivation . . .	371.26	49.50	94.17	11.35
General . . .	144.16	19.22	—	—
Couch Control . .	949.92	126.65	550.69	66.35
Shs.	5,958 03	794 40	Shs. 5,180 59	624 16

TABLE LXXVI

Coffee Development on 8.51 Acres

	1.4.59 to 30.6.60	*1.7.60 to 30.6.61*	*1.7.61 to 31.3.62*	*Total*	*Cost per acre*
Land Preparation Prior to Planting. Ploughing/Discing . .	551.69			551.69	64 83
Soil Conservation. Terracing, Roads, etc.	861.05			861.05	101.18
	1,412.74				
Planting:—					
Nursery Expenses	1,583.87			1,583.87	186.11
Marking/Holing	1,108 02			1,108.02	130.20
Fertilizing/F.Y.M.	1,618 62			1,618.62	190.20
Planting/Shading	1,387.79			1,387.79	163.07
Sundries/Transport	510.30			510.30	59.96
	6,208 60				
Mulching	2,011.44	709.25	1,643.52	4,364.21	512.83
Cultivation/Weeding	688 19	317.85	467 92	1,473.96	173.20
Couch Control	498 19	—	120 88	619 07	72.74
Irrigation (Hand)	402 12	40.52	13 08	455 72	53.55
Pest Control	40.00	42 33	16 32	98.65	11.60
Stripping	—	92.47	365 04	457.51	53.76
Pruning/Handling	26.51	216 09	217.60	460 20	54 07
Fertilizing	172 10	360 55	67 44	600 09	70 53
Tonic Spraying	147 86	267 56	59 04	474 46	55 75
Overheads and Depreciation . .	955.80	906 00	1,128.00	2,989 80	351.33
	12,563 55	2,952 62	4,098 84	19,615 01	2,304 91

= £115 per Acre.

SUBSTATIONS

Development continued on the Kisii, Meru and Koru substations. Coffee factories have been completed at both Kisii and Koru. There is now a rapidly increasing flow of experimental results coming from these substations, and these have been reported on in the chapter on Field Investigations.

Kitale Experimental Station

Rainfall 1.1.61 to 31.12.61 (inches)	66.72
Acreage in production	14.6
Clean Coffee (tons)	3.43
Mbuni (lb.)	2,100

In addition to the above, experimental samples amounting to 210 lb. parchment and 1,231 lb. seed were produced from the bearing acreage from which the average yield was 4.7 cwt. per acre.

The first quarter of 1961 proved to be extremely dry, followed by unusually heavy rains until the end of the year. Coffee Berry Disease became fairly widespread during the latter part of the year. At the present time, the general condition of the coffee, having borne an average crop during the season, is extremely good and prospects for future cropping appear to be favourable.

Koru Substation

A considerable amount of development was carried out during the year, including the erection of a coffee factory, office block, implem nt store and additional housing.

Approximately 25 acres of bush were cleared for rough grazing.

A new variety trial was put down on 3.7 acres and the Leaf Rust trial extended. A three-acre seed production block was also planted. The $1\frac{1}{2}$ acres of mature coffee produced a heavy crop.

Kisii Substation

The development programme is now nearly complete with housing for two Field Assistants erected during the year and equipment installed for experimental sampling. Further areas have been put under mulch grass and a collection of 18 grass species were planted.

A wide range of trials are now under way and the first yield results from trials on this station became available during the year.

Meru Substation

A small pulpery, water tank and store were erected during the year to handle the one-tenth cherry samples taken from experimental plots for calculation of cherry/clean coffee ratios.

Growth recording studies were commenced on the station to enable spray timing recommendations to be made for the control of Coffee Berry Disease, which extended its range during the year in Meru district.

As at Kisii this station now has a wide range of trials under way, and the yield results from some of these were obtained during the year.

Upper Kiambu Substation

Trials have continued on fertilizers, manures, pruning and spraying, but have not been in progress long enough to provide clear results.

The routine copper sprays applied in February and March held Coffee Berry Disease in check until December, but thereafter the crop had to be picked in a partially ripe state in order to avoid serious loss from the Brown Blight form of the disease. It appears probable that a copper spray would have been advisable in August or September, before the Short Rains.

The new stand of shade trees has developed well, but some of the old *Grevillea* were still alive over two years after ring-barking. Part of the steep land was cleared of bracken and couch and made into bench terraces suitable for planting coffee. The supply of clean water for domestic purposes continued to present a serious problem.

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